

AMD vs INTEL \$800 PC BUILD FACE-OFF

apc

May 2018
Issue 454

YOUR EXPERT

GUIDE TO TODAY'S TECH



TWO RIGS ENTER:
ONE RIG LEAVES!

WE PIT A PAIR OF
BASIC-BUT-BALLSY
DESKTOPS AGAINST EACH
OTHER — FIND OUT
WHO OFFERS THE BEST
BANG FOR BUCK!

COMPLETE GUIDE

THE PC BUILDER'S BIBLE

WE'VE MADE BUILDING YOUR OWN PC EASY!
DODGE COMMON PITFALLS, FIX TROUBLESOME
BOOT CONUNDRUMS & ENJOY EVERY MINUTE!

PLUS **DIY KICK-ARSE COMPACT PC**

MINI-ITX + MICRO-ATX MOTHERBOARDS
& CASES FOR AMD & INTEL
COMPARED + RATED



REVIEWED
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PRACTICAL & HANDY HOW-TOs

- DISCOVER iOS'S HIDDEN SPEED-TYPING TOOLS
- ORGANISE CONTACTS IN WINDOWS EFFECTIVELY
- CREATE A RASPBERRY PI REMOTE HACKING TOOL

PLAY WINDOWS GAMES ON LINUX

REVEALED: HOW TO MAKE THE SWITCH TO LINUX AND STILL PLAY ALL YOUR FAVOURITE WINDOWS GAMES!

SMOKIN' HOT TECH REVIEWED

- INTEL & AMD MINI-PC TEAM UP: HADES CANYON NUC TESTED
- RASPBERRY PI 3 B+: A FAST AND CHEAP HOBBYIST'S DREAM
- INTEL'S FIRST OVERCLOCKABLE LAPTOP CPUs HAVE LANDED



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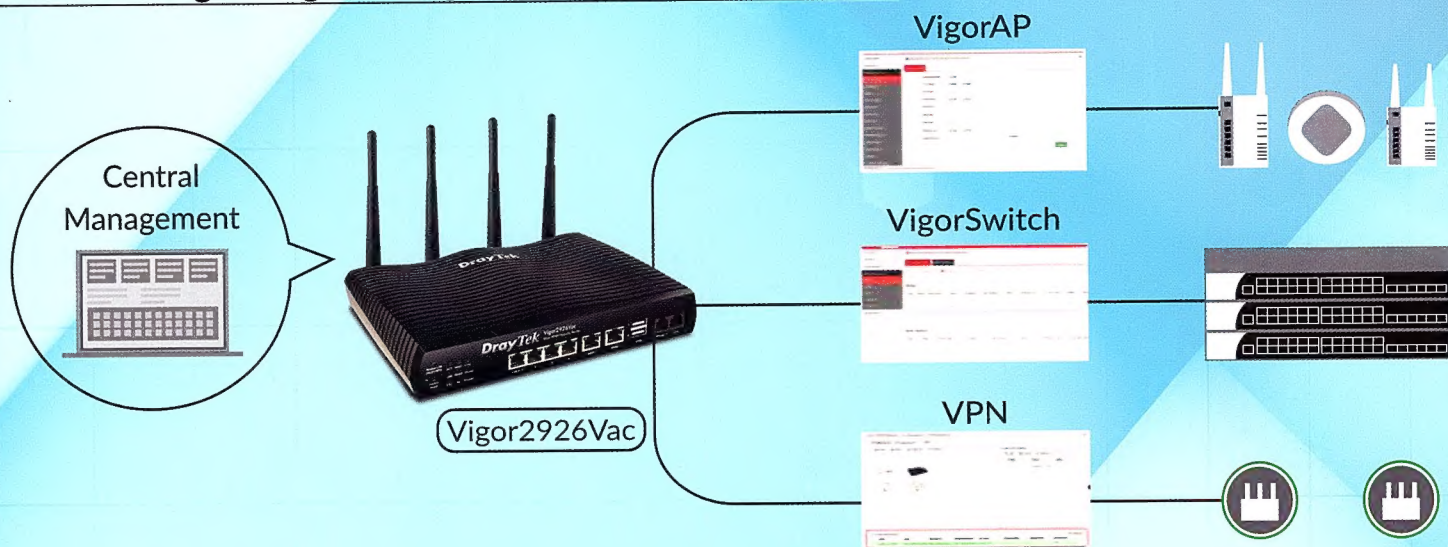


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The digital privacy conundrum

Have we finally reached a tipping point
when it comes to the treatment
of our personal data?



We've all known,
at some level, that if
you want stuff for
free, the provider
of those goods or
services needs to
find some other way
to monetise it –

and that when it comes to the likes
of Google and Facebook's
platforms, we're as much the
product as we are the users.
A digital economy that's largely
built on ad sales means that some
degree of user tracking is going
to be the norm.

So why are we suddenly so
shocked about potential breaches
to our digital privacy? The real
watershed moment – which we all
seem to have been living through
in horrifying slow motion since
2016 – is the realisation that this
personal info is useful beyond just
figuring out what ads to serve
specific users and can, perhaps,
be used to identify people's
political persuasions and then
target them with information
(often false) that serves to polarise
opinions. Ultimately, that makes
the political dialog that's so critical
to a functional democracy more
difficult.

So besides quitting social media
entirely, what can we do about it?
Locking down your privacy
settings is certainly a good first
step, although the level of access
we're given to these does vary

depending on our location.

The EU's got tough new privacy
laws (known as the General Data
Protection Regulation, or GDPR)
that come into effect on May 25th,
2018, and will force the likes of
Facebook to be very transparent
about what personal data is being
collected and how it is (and can)
be used.

At present, Australia doesn't
have a direct equivalent to the
GDPR (we still largely rely on the
pre-internet Privacy Act 1988
for our digital privacy laws), but
there has been talk among our
politicians of eventually
implementing one.

In the meantime, how much
privacy you have often comes down
to how much you're willing to roll
up your sleeves and get into the
guts of your account and/or
application settings.

We've detailed how to do that
for specific platforms many times
over the years in APC – privacy
is very much woven through the
fabric of both our mag and our
sister publication *TechLife* –
and we will, of course, continue
to provide detailed and useful
information when it comes to
safeguarding your personal data
as we travel into our ever-more-
digital future. ■

DAN GARDINER
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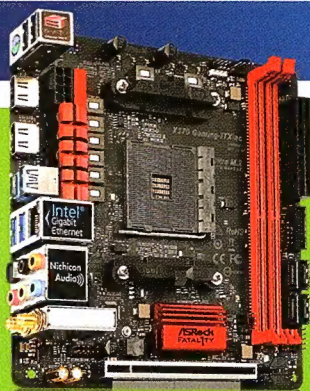
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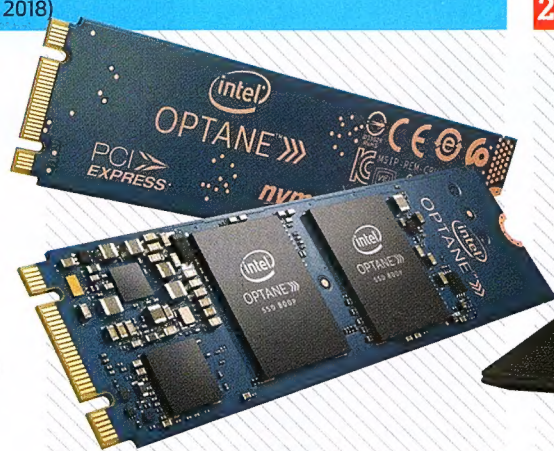
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» LATEST REVIEWS

apc
HOT PRODUCT

Intel Hades Canyon NUC (NUC8i7HVK)

Intel Hades Canyon NUC (NUC8i7HVK)

The ultimate power play of mini PCs

Intel's Next Unit of Computing hardware platform has always showcased some of the chipmaker's most interesting silicon concepts. This year, the Hades Canyon NUC represents a partnership between Intel and AMD we would have never expected – or even dreamed.

It's easily the smallest VR-capable PC that marries together an Intel quad-core processor with integrated, discrete-class AMD Radeon RX Vega graphics into a single chip. With all that power under its belt, this gaming PC easily smashes through Full HD gaming with most modern titles and performs like a productivity champ.

Despite all the carvets of that comes with a barebones computer such as this, the Intel Hades Canyon NUC earns top marks for packing so much performance into a small package. It's one of the

best and our favourite mini PC of the year so far.

PRICE/PERFORMANCE

Our particular Intel Hades Canyon review unit costs \$1,399, which is about a third off the price of an equally competent gaming laptop. Hot too, though, for a PC equipped with a quad-core Intel Core i7 and nearly Nvidia GeForce GTX 1050 equivalent graphics.

That said, this barebones unit doesn't come with storage, memory or an operating system, so you'll have to add those pieces on your own, which will add at least another \$300 to the cost.

There's also an entry-level Intel Hades Canyon NUC87KHKE priced at \$1,150, but while it still comes with a quad-core Core i7 CPU, it makes out at a slower frequency and, moreover, the onboard Radeon RX Vega M GL GPU has four fewer compute

units and therefore won't run as fast either.

Compared to other barebone PCs, the high-end Intel Hades Canyon NUC compares well against the \$1,599 Zotac Zbox Magnus EN1060K and \$1,499 Gigabyte Erix GP-B07R06-1050. Both of these mini PCs feature older Kabylake processors but a GTX 1050 with two more gigs of video RAM and higher CUDA.

DESIGN/FORM FACTOR

At first blush, the Hades Canyon NUC looks more like a set-top box than a desktop PC, and that's honestly a good thing. The device is interesting enough to look like more than just a plain box in your home entertainment setup while also not being too distracting if you decide to use it as your work computer. If you remember the Skull Canyon NUC (Intel)

released two years prior, the Hades Canyon should look very familiar. Both units share the same overall shape, plus an identical hexagonal motif for the ventilation holes and top panel. Of course, with the integration of discrete-class graphics and sufficient cooling to back it up, Intel's flagship NUC is almost twice as large as its predecessor.

Intel's design has also seen some improvements. The old interchangeable plastic panels have been replaced by a much slicker light-up skull fashioned after the silicon that resides within. The lighting on this part of the case and all the little hard drive and power indicators are fully customizable – or you could just turn them all off for a stealthy unit.

Despite this PC's small size, it packs an impressive amount of ports. Along the backside, you'll find

Apple iPad
(9.7-inch, early 2018)

Dell Inspiron 15
7000 Gaming (7577)

SteelSeries
Rival 600

The North Face
Iron Peak

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

Tasmania takes Basslink to court

THE ISLAND STATE KEEPS GETTING CUT OFF.

Just before Easter this year, the electricity and communications cable connecting the Australian mainland to Tasmania was damaged during routine maintenance, leaving the island state to fulfil its energy needs for a fortnight by itself.

While that's something Tasmania can handle, the similar six-month long outage that occurred in December 2015 cost the state government millions. The Tassy Government is now taking Basslink, the company that runs the undersea cable, to court, suing for damages of over \$100 million. SS

Intel won't be patching Spectre v2 flaw in older chips

CHIPMAKER GOES BACK ON ITS WORD.

When Meltdown and Spectre raised their menacing heads (see page 70), Intel promised that all of its chips would be patched for both bugs, but the chipmaker can't figure out how to fix some of its older products and won't be receiving updates for the Spectre v2 flaw. These include the Bloomfield, Clarksfield, Gulftown, Harpertown, Jasper Forest, Penryn, SoFIA 3GR, Wolfdale and the Yorkfield ranges. Admittedly, the number of systems still using these chips is small, and Intel has suggested users should upgrade their systems if they want protection. SS

Ecuador cuts off Julian Assange's access to the internet

TO KEEP HIM FROM "MEDDLING".

Ecuador's London Embassy, the home of Julian Assange since 2012, has cut off the Wikileaks founder's internet access in a bid to stop him from "meddling in other countries' affairs". Assange took to Twitter to question the accusations laid by 20 countries against the Kremlin for the nerve agent attack on a Russian ex-spy and his daughter in the UK. The British Foreign Office responded by calling Assange a "miserable little worm". SS



Australians may cop a \$5 tax on all goods posted from overseas

That's on top of the impending online GST.

A proposal from the Department of Home Affairs has suggested that Australian shoppers purchasing goods from overseas pay an additional fee of \$5 on every item posted. The proposed tax would be put in place to cover the growing cost of security screening, a paper obtained by Fairfax Media claims, as the number of items posted to Australia that are valued under \$1,000 increase dramatically year on year.

This cost will sit atop the existing 10% GST that will apply to all sales from July 1st this year, rather than on only those over \$1,000 in value, and has the potential to increase certain parcel costs by more than double their initial value. While there would have been scope for this cost to be absorbed by online retailers such as eBay and Amazon, or delivery services, both of these parties have said in the past that the levy will be passed directly onto the consumer. So expect to pay up if the proposal goes through. Harry Domanski

New NBN wholesale pricing has helped improve speeds and reduce congestion, according to ACCC

SPEEDS ARE UP, ACCORDING TO ACCC'S FIRST REPORT.

NBN Co's recent overhaul of wholesale pricing has made it easier, and cheaper, for retail providers (RSPs) to make good on their internet speed promises to customers. The ability to purchase more bandwidth has led to a decrease in peak-time congestion, as revealed by the first report released on speed tests by the Australian Competition and Consumer Commission (ACCC). According to the new report, Telstra, Optus, iiNet and TPG are delivering download speeds that are only 10–20% slower in the busiest hours (7–11pm) than the maximum plan speeds. That said, the ACCC found that 5% of all customers were still only achieving less than half of the maximum speeds that their plan promised them.

However, the NBN price cuts are here to stay, so RSPs that were steering clear of unlimited broadband plans are now open to the idea, with one telco, Aussie Broadband, already having announced it'll be offering unlimited NBN services come May 1st. It's the same telco that has previously blamed unlimited plans for the less-than-average speed performance on the NBN network. Sharmishta Sarkar



Facebook under fire for mass leak of users' private data

More than 300,000 Australians among those affected.

Facebook is facing international investigations into the illicit harvesting of users' personal data. The information was collected by Cambridge Analytica (CA), a political consulting firm that was used by President Trump's 2016 election campaign and is linked with the Brexit 'Vote Leave' campaign. According to a whistleblower, CA gathered data from 50 million users (an initial estimate), then developed a software program that profiled these citizens to predict voting patterns – and, through micro-targeted ads, influence voting decisions.

The data was obtained via a third-party app in 2013, 'thisisyourdigitallife', that participants willingly signed up for and thus gave up permissions. But it then pulled the personal data of these users' Facebook friends without their consent, vastly increasing the data pool from the initial 200,000 users. Facebook altered its platform the following year, blocking this kind of loophole, and when it became aware of Cambridge Analytica's breach in 2015, Facebook apparently ordered it to delete the data. Mark Zuckerberg has since made a statement promising to investigate all apps that had this kind of access prior to the 2014 overhaul and 'fix' users privacy concerns. As a result, the social media platform has made its privacy settings more transparent and easily accessible and the ability to remove Facebook account information from third-party apps has been streamlined.

It has since been claimed in a statement from Facebook that the total number of individuals whose data was accessed was closer to the 87 million mark – although CA has denied that new figure, stating that it only collected the information of 30 million individuals. According to Facebook, users from countries such as the Philippines, Indonesia, India, Mexico and the UK were part of the data haul. Australia itself was affected as well, although its 300,000 users only comprised 0.4% of the overall 87 million, of which the US made up the vast majority at 81.4%. Shortly after the figures were revealed, Mark Zuckerberg admitted during a conference call that Facebook "...didn't take a broad enough view on what their responsibility was and that was a huge mistake. That was my mistake." Harry Domanski

Government spending \$6 million on tech for pre-schools

HOPING TO ENCOURAGE LEARNING IN STEM SUBJECTS.

A \$6 million program being developed by the Australian Government will introduce tablets with interactive apps and other technically-focused workshops to pre-schoolers, in the hope of sparking greater early interest in STEM subjects (Science, Technology, Engineering and Maths). The investment follows a successful early-learning English program that employed similar methods, and will be trialled on 4,000 children in the coming months. HD

ACCC to force NBN Co to reveal more network specifics

LOCAL CONNECTION TYPES AND NUMBERS TO BE LISTED.

The Australian Competition and Consumer Commission has announced that its ongoing quarterly NBN reports will now be required to include more detailed info, including the number of NBN connections by their geographic region, network technology, speed tier and traffic class. It will also include data on the total bandwidth capacity purchased by all of the NBN resellers combined; however, it won't be possible for the public to determine how much each individual service provider has purchased, as it is claimed that such data could be misunderstood – although the ACCC will be monitoring these numbers internally. HD

Apple Watch data could lead to murder conviction

DEVICE LOGS COULD BE CRITICAL EVIDENCE.

The prosecutor in the murder trial of an Adelaide resident has used the victim's Apple Watch Health data to narrow down their time of death to a 7-minute window. The victim's activity (and, sadly, subsequent lack of activity) happen to be at odds with the story of the accused murderer, who allegedly sent a text message and made an eBay purchase posing as the victim more than half an hour after the crime was committed. HD

numbercrunch

» HARRY DOMANSKI LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS



\$3.23 BILLION

AUSTRALIANS SPENT UP BIG ON VIDEO GAMES IN 2017

Australia's Interactive Games and Entertainment Association (IGEA) has released figures showing an overall increase in the purchase of video games in 2017 over that of 2016. A total of \$3.23 billion was spent on the interactive entertainment option throughout the year, which represents a 9% increase over 2016's sales. Despite the increasing prevalence and availability of digital copies of games, both digital and physical releases shared a similar increase in their sales.



1 in 2

LESS THAN HALF OF RANSOMWARE VICTIMS THAT PAY UP GET THEIR RANSOMED FILES RETURNED

Funnily enough, it turns out that the people responsible for ransomware attacks are also fairly untrustworthy. American cyber security company CyberEdge has found that, of those that paid the ransom for their locked-down software, only half were ultimately able to recover their files successfully. However, of those that simply ignored the ransom demand, 86.9% were able to retrieve their data — most commonly via a system restore or another back-up method. In other words, if you have important files, make sure you back 'em up!



9.4%

AVERAGE COST OF AUSSIE FIXED INTERNET HAS DROPPED FURTHER THAN IN ANY PREVIOUS YEAR

According to the ACCC, the average price for a fixed internet connection in Australia has fallen by 9.4% over the last financial year, a drop that almost doubles the average decline seen in the last four years. And perhaps because of this, data usage among Aussies is also soaring — between April and June in 2016, we downloaded around two million terabytes in total, but the same three-month window in 2017 saw that number increase to three million terabytes.



\$347,000

AUSTRALIAN BUSINESSES FORCED TO PAY FOR UNLICENSED SOFTWARE

A report released in March has revealed that, over the course of 2017, the Software Alliance settled 28 cases of Australian businesses using unlicensed software, resulting in over \$347,000 in damages. Among them was a Western Australian energy company that settled for over \$40,000 alone. Beyond the copyright infringement damages that these companies were ordered to pay, they were also forced to purchase genuine licenses for the software they were using.



1.35Tbps

GITHUB WAS HIT WITH THE WORLD'S BIGGEST DDOS ATTACK, BUT SURVIVED UNSCATHED

At the end of February, popular developer platform Github was hit with the most powerful DDoS attack ever to be recorded, peaking at 1.35Tbps via 126.9 million packets per second. The attack came from "over a thousand different autonomous systems across tens of thousands of unique endpoints", according to Github. Despite its devastating size, however, Github hosting-provider Akamai's anti-DDoS technology meant the attack only took the site down intermittently over the course of 10 minutes before it returned to normal. Nothing is currently known of the attackers or their intentions. ■

tech**brief**

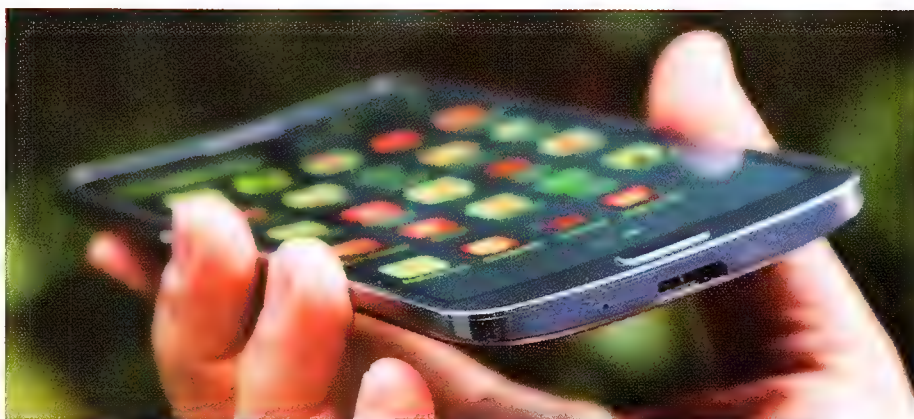
» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK

The fictional and futuristic world of flexible tech

Not all innovations in the smartphone realm are as popular as the touchscreen...

Phones. They used to have buttons and a lanyard hole (that accessory loop you'd attach a charm or three onto).

They also used to be plasticky, brick-like in design and fit into your average pocket. Now, however, thanks to many innovations over the years, they're 'smart', sleek, smooth, huge, thin, packed with pixels and can pretty much do anything you want them to do, barring making you a cup of coffee or giving you your morning shave (but that's not from want of trying). But what about those weird inventions that were left by the wayside, and what's on the horizon? This month, we take a look at the weird designs you may have forgotten and give you a sneak peek at some rumoured next steps for our favourite devices.



Samsung Galaxy Round

Curved screen phone

Many people jumped on board the curved TV phenomenon (for some reason), and more still grabbed themselves a curved monitor. But despite having an impressive specs sheet for the time, the Samsung Galaxy Round, released in 2013, was not the great leap forward that many industry professionals were claiming it would be. Perhaps that's because it curved the opposite way you would expect, but also because it was quite chunky. So why bother?



Samsung Galaxy X

Foldable display smartphone

There's a limit to how big a phone can be, to enable its users to hold it and keep it in a pocket or handbag. However, if the device can be folded, it can suddenly potentially become a lot bigger when in 'open' mode. The Galaxy X purportedly bends in the middle and has been a concept since 2013, but whether or not the company is still actively pursuing the design at present is unknown.



Lenovo Cplus

Smart watch or smartphone?

This one reminds us of slap bracelets. Lenovo revealed its concept for the Cplus midway through last year — a device that can wrap around the wrist like a smart watch, but can presumably also be used normally as a rather long phone. While it's currently not fit for sale, the company expects similar devices will be available to the public within the next few years.



PaperTab

Wafer-thin tablet

Intel Labs and Plastic Logic have teamed up to create a truly revolutionary prototype for the future of tablets. The PaperTab is a fully interactive, flexible, high-res 10.7-inch plastic touchscreen. "Within five to ten years, most computers ... will look and feel just like these sheets of printed colour paper," claims the Director of the lab in which the PaperTab was created. We'll just have to wait and see!



Vivo Apex

With a pop-up selfie cam

Modern phones have big screens already, but one thing holding them back from taking up the full front of the phone is the selfie camera. Chinese manufacturer Vivo has come up with a unique workaround — a camera that slides upwards out of the phone's top when needed. While only at the concept stage at present, this bezel-less phone looks pretty stunning and we can't wait to get our paws on it. ■

gadgets

» GEAR WE WANT

SENSIBO SKY

Bring your existing aircon unit into your smarthome.

\$159 | SENSIBO.COM

Once you've connected a couple of devices to your smart home network, it's inevitable that you'll start to wish that every object in your house could be controlled through your smart assistant or a scheduling app – and one of the first you're likely to want to link up is the air conditioner. Sensibo Sky is an interconnected, infrared remote hub that aims to be the missing puzzle piece between your existing remote-controlled air conditioner and your smartphone or smart speaker. The device uses traditional remote controls to sync with your AC and connects it to your Wi-Fi, letting you change the temperature, fan speed and mode through the app or by asking your digital assistant – both of which work when you're out and about, so you can pre-cool or warm your abode for when you get home. **JB**



BOSE AR SUNGLASSES

AR-e you getting enough audio information?

\$TBC | DEVELOPER.BOSE.COM/BOSE-AR

While AR is generally thought of as a visual information system, sound can also be an effective way to augment reality. At this year's South by Southwest festival in Austin, Texas, audio company Bose made a surprise announcement for a prototype pair of AR sunglasses that'll give you contextually-relevant information using a pair of speakers on the arms of the glasses. Demonstrations showed a person wearing the glasses getting information about a restaurant's menu, seating capacity, wait-time, ambiance and user reviews – and all they had to do was look at the restaurant and tap the headset. Bose has committed a US\$50 million prize pool to encourage developers to integrate apps into the auditory AR system. **JB**

WANLE GAMER'S CONSOLE FOR iPhone

Make your phone fun again.

US\$24.95 | WANLECASES.COM

While modern iPhones have Retina touchscreen displays, hexa-core CPUs and LTE cellular chips that allow them to easily download and play large games on the go, sometimes no amount of technology can supplant the pure nostalgia people have for popular games of yesteryear. Wanle Cases is attempting to bring together the old and the new with this case that effectively straps a classic Nintendo Game Boy – with monochromatic screen – onto the back of any iPhone 6 or newer handset. The case comes loaded with 10 popular titles including *Tetris*, *Snake* and *Tank* and has a familiar Game Boy button layout. **JB**





KLIPSCH THE SIXES

Welcome to 1973.

US\$799.99 | KLIPSCH.COM

It's time to put some seriously '70s hi-fi style back in your life. This audio system combines totally modern tech with a wood finish and brassy metal details with proper physical controls, including some retro switches you won't be able to stop playing with. These speakers are active, meaning you don't need an amp to power them — just plug in anything from your Mac to your record player (they have a phono pre-amp). And they even have Bluetooth for wireless playback from your phone, too.

LIFX BEAM

Scotty would be in heaven.

US\$199.99 | LIFX.COM

Modular smart lights are getting to be a big thing, and we're kinda digging the minimalism of this set. The kit contains six strips and a corner piece, so you can create an L-shaped strip of light that highlights an area of your home (or office), instead of being a big centerpiece. Each beam has 10 colour zones, so you can get great smooth gradients of hues across the whole thing. They integrate with Apple HomeKit, Amazon Alexa, Google Home and tons of other smart home products, too — or alternatively, can simply be controlled from the LIFX phone app.



LIGHTHOUSE AI

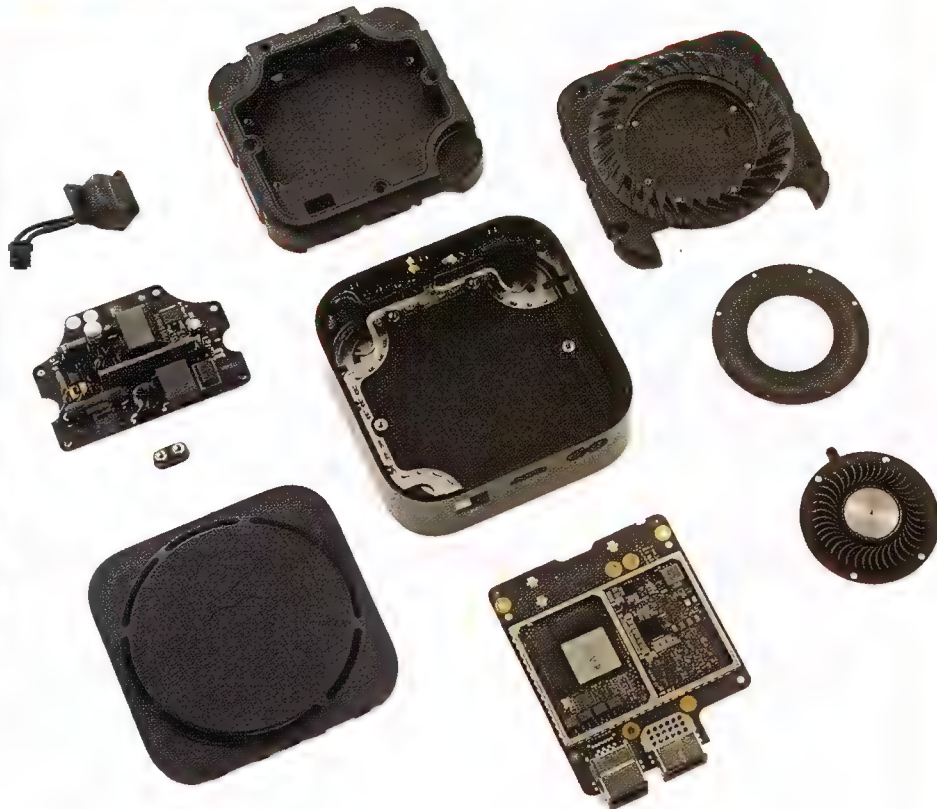
"I can absolutely do that, Dave."

US\$299 + SUBSCRIPTION | LIGHT.HOUSE

This smart home camera brings AI to video security. For a start, it's better than older cameras at picking out things you need to know — it won't mistake a sudden change in lighting as movement and send you a false alarm. It also has excellent facial recognition, two-way communication, night vision, and a full HD sensor. The really neat part is that you can get information from it by just asking it — either using your voice, or by typing it in: "Let me know when Ellen gets home today" will get you a notification. "Did you see David today between 10am and 1pm?" will search for a clip. Has the potential to be ingenious. ■



how it's done



Apple TV 4K

It's what's on the inside that counts.

Today on our teardown table, we have a shiny new Apple TV 4K. So what are we to do with Apple's first 4K HDR streaming device? Binge-watch *Stranger Things*? We definitely thought about it... but, nah, we're tearing this sucker apart!

MAJOR TECH SPECS

- 64-bit Apple A10X Fusion chip
- Gigabit Ethernet, 802.11ac Wi-Fi, Bluetooth 5.0, IR receiver, HDMI 2.0a
- In the remote: glass touch surface, dual microphones, accelerometer, gyroscope, Bluetooth 4.0, IR transmitter, Lightning connector

KEY FINDINGS

- The newest Apple TV doesn't tower over its predecessor, but we notice a couple of key differences in the design. The bottom panel has been redesigned for what looks like thermal venting. Bye-bye, USB-C port. Just like with its single-K sibling, the Apple TV 4K features repair-friendly plastic clips that secure its bottom panel. No moat of glue or uncommon screws? This upgraded unit gets a thumbs up.
- Peeling back the rear panel reveals a beefy fan secured by some T7 Torx screws. After pulling them out, we

meet Apple TV's biggest fan! It looks as though Apple merged the new fan with the heatsink/EMI shield assembly from the Apple TV 4th Generation, combining them to form a whopper of a cooling solution. This thermal assembly suggests that 4K HDR capability comes with a significant increase in thermal output. A twist of a few more Torx screws disassembles the assembly, revealing a replaceable fan driven by a Nidec brushless motor.

- Apple keeps with the tradition of easily removable logic boards for the Apple TV 4K. We don't run into any surprises here; the heatsink remains the same as its predecessor from 2015. We take a moment to pluck a familiar pair of presumed power posts from the body of the heatsink.

During our Apple TV 4th Generation teardown, we suspected that power was transmitted to the logic board via the heatsink screw posts. It looks as though this is still the case. With the heatsink and posts out of the way, the only thing left to do is remove the power supply board.

- The new power supply is rated for 12V at 1.083A. This is a modest bump from the 0.917A power supply we saw in the Apple TV 4th Generation. Again taking a design lead from its older sibling, the Apple TV 4K eschews internal wiring between the power supply and logic board. The use of conductive posts in lieu of wiring probably saves internal real estate and eliminates the possibility of pinched or bent wires during assembly.
- **Repairability Score:** 8 out of 10 (10 is easiest to repair). Plastic clips hold the case together for easy opening. Modular components make for easy disassembly and repair. Power supply is modular and features a removable AC-in jack. Standard Torx screws hold everything together. All major components are soldered to the logic board, meaning fixing any port problems will require board-level soldering or a full board replacement. ■

About iFixit

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- Windows® 10 Home

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- NVIDIA® GeForce® GTX 1060M 6GB GDDR5
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- Windows® 10 Professional

DreamBook Power P87 VR SLI

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6 X
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"I visit a lot of news websites and, since I'm a bit stingy, I don't have any paid memberships for their services, meaning I get served up all sorts of ads."

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TOPICS THAT

Remove topics that you don't like and add ones that you do to make the ads you see more useful to you. Topics will also be added as you use some Google services (ex: when you watch a video on YouTube). We're working to include topics from other Google services.

Comics & Animation



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TV Sci-Fi & Fantasy Shows



Urban Transport



NEW TOPIC

COOKIE MONSTER MADNESS

Privacy and personal online security is a hot topic of conversation these days, so I thought I'd follow some of your advice; namely to do with changing passwords, making them unique to all my online accounts and removing cookies, just in case my device gets stolen.

However, I might have gone a bit overboard, as I got rid of, well... all of them. I visit a lot of news websites and, since I'm a bit stingy, I don't have any paid memberships for their services, meaning I get served up all sorts of ads. Due to the fact that I often shop for things online (soccer boots, the odd bit of tech, clothing and that N7 hoodie my son stole from me), the ads I saw were more often than not catered to my interests. I used to see deals for new tech, notices of sales on the websites

I frequent or weird nerdy merchandise. But now that I've rid my browser of all its cookies, I'm landed with things like women's fashion, tents, chick flicks and holidays I could never afford!

I want my old ads back! I suppose it's just a matter of time before Chrome re-learns my ways and I see all the 'nice' ads again, but until then, I'm just going to have to put up with it... No, thanks, SEEK, I'm not looking for a new job right now, go away. Oh, and I'm not looking to open a random business account with anyone, thanks, CommBank. Sorry.

Jim Bligh

Ed replies: Yep, I've experienced the same thing since adjusting Google's ad personalisation settings for my main account — you can find these options by using your web browser to navigate to

myaccount.google.com, then 'Personal info & privacy > Ad Settings'.

While I've turned 'personalisation' off completely, Google is actually pretty flexible in the settings it provides when it comes to tailoring what ads you want to see. You can specify topics you're interested in (which Google will automatically populate based on things like your web searches) and even blacklist those you're not, as you can see in the screenshot above.

Adjusting these to better suit your interests is perhaps a more ethical approach to just using an ad blocker: it means you'll still be supporting the free websites you visit that rely on advertising to pay the bills, but you'll also cut down on the amount of irrelevant ads and info that would otherwise be thrown your way.

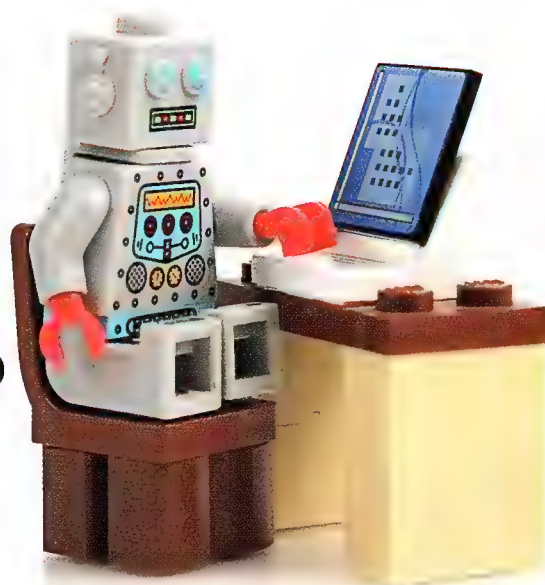
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Our AI future could increase demand for artists — but what about low-skill labour?

Artificial intelligence promises to liberate us from menial tasks. 'Do we really want that?' asks Shaun Prescott.



The rise of AI and machine learning shows no sign of slowing down, but the gravity of its development seems lost on most. But the industry and field of study continues to grow apace, with Silicon Valley seemingly determined to eliminate the jobs of millions via automation — and without stopping to wonder how all those people will survive.

Well, if automation means there're no checkouts at Coles to man or trucks to drive, how's an arts degree sound? In 2018, pursuing a 'career' in arts — or indeed, any form of work that isn't profit-for-profit's-sake — seems like a ticket to poverty and bitterness. But according to Eric Berridge, a "business technology specialist" for global consulting firm Bluewolf, it's those with arts know-how (rather than, say, engineering) which will be most sought after in this AI-driven future.

Berridge said as much during a recent Salesforce event in Sydney, according to a story on Business Insider. Bluewolf is a company which, among other things, specialises in consulting with businesses regarding "transformation technology" (ie, stuff like AI) and recently joined the IBM family. Basically, Berridge reckons that as engineers iterate on technology, it will become so easy to use and so

"Well, if automation means there're no checkouts at Coles to man or trucks to drive, how's an arts degree sound?"

streamlined that arts graduates could apply their artistic touches in fields that would otherwise be out-of-bounds to them.

"If you look at people we hire at Bluewolf, we have thousands of practitioners globally. Very few of them have degrees in pure science. We're hiring artists, we're hiring musicians we're hiring a whole different class of degrees than a tech company would typically hire.

"STEM is very important for society, but you go on LinkedIn today and look at jobs that are currently posted for organisations like Google, Apple, Amazon, you'd think that 80% of all their hires require degrees in engineering and computer science," he says. "It's actually the opposite. We're a big believer in the creative process when it comes to how organisations evolve. We're big believers in how people communicate and how the human experience feeds the outcome of that other initiative." Now, Berridge was speaking at an

industry event, anecdotally, so it's hard to point the finger. But it's a common enough attitude among (wealthy) leaders in technology companies: automation and AI will create more not less work. But even if that's true, for whom are these jobs for?

The reality of automation is pretty grim if you're neither an engineer or hold an arts degree or, indeed, work in jobs requiring no official qualifications. Late last year, the US Bureau of Labor Statistics released a report which outlined that electronics assemblers and word processors would have 45,300 and 25,000 fewer jobs in the market thanks to automation. And while demand for other fields will continue to rise — statisticians, developers, mathematicians — these are all high-skill jobs. Notice a pattern here? The one major exception, of course, is online retail-fulfilment centres. So we can all at least look forward to our futures of packing boxes for Amazon, with heart monitoring wristbands to make sure we're all working effectively... ■

END USER

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INTEL NUC

\$1,399 | WWW.INTEL.COM.AU

Intel Hades Canyon NUC (NUC8i7HVK)

The ultimate power play of mini PCs.

Intel's 'Next Unit of Computing' hardware platform has always showcased some of the chipmaker's most interesting silicon concepts. This year, the Hades Canyon NUC represents a partnership between Intel and AMD we would have never expected – or even fathomed.

It's easily the smallest VR-capable PC that marries together an Intel quad-core processor with integrated, 'discrete-class' AMD Radeon RX Vega graphics into a single chip. With all that power under its belt, this gaming PC easily smashes through Full HD gaming with most modern titles and performs like a productivity champ.

Despite all the caveats of that comes with a barebones computer such as this, the Intel Hades Canyon NUC earns top marks for packing so much performance into a small package. It's one of the

best and our favourite mini PC of the year so far.

PRICEY BUT PUNCHY

Our particular Intel Hades Canyon review unit costs \$1,399, which is about a third off the price of an equally-competent gaming laptop. Not too shabby for a PC equipped with a quad-core Intel Core i7 and nearly Nvidia GeForce GTX 1060 equivalent graphics.

That said, this barebones unit doesn't come with storage, memory or an operating system, so you'll have to add those pieces on your own, which will add at least another \$300 to the cost.

There's also an entry-level Intel Hades Canyon NUC8i7HVK priced at \$1,150, but while it still comes with a quad-core Core i7 CPU, it maxes out at a slower frequency and, moreover, the onboard Radeon RX Vega MGL GPU has four fewer compute

units and therefore won't run as fast either.

Compared to other barebone PCs, the high-end Intel Hades Canyon NUC compares well against the \$1,599 Zotac Zbox Magnus EN1060K and \$1,499 Gigabyte Brix GB-BNi7HG6-1060. Both of these mini PCs feature older Kaby Lake processors but a GTX 1060 with two more gigs of video RAM and higher CUDA.

LOUNGE ROOM FRIENDLY DESIGN

At first blush, the Hades Canyon NUC looks more like a set top box than a desktop PC, and that's honestly a good thing. The device is interesting enough to look like more than just a plain box in your home entertainment setup while also not being too distracting if you decide to use it as your work computer. If you remember the Skull Canyon NUC Intel

released two years prior, the Hades Canyon should look very familiar. Both units share the same overall shape, plus an identical hexagonal motif for the ventilation holes and top panel. Of course, with the integration of 'discrete-class' graphics and sufficient cooling to back it up, Intel's flagship NUC is almost twice as large as its predecessor.

Intel's design has also seen some improvements. The old interchangeable plastic panels have been replaced by a much slicker light-up skull fashioned after the silicon that resides within. The lighting on this part of the case and all the little hard drive and power indicators are fully customisable – or you could just turn them all off for a stealthy unit.

Despite this PC's small size, it packs an impressive amount of ports. Along the backside alone you'll find



"Cracking open the Hades Canyon NUC is a breeze, as it just requires undoing six torx screws and a single Philips head"

four USB 3.0 ports, two ThunderBolt 3 ports, two mini DisplayPorts, HDMI 2.0 and even two Gigabit Ethernet ports. That's more connectivity than you'll even find on some full-size desktops.

Cracking open the Hades Canyon NUC is a breeze, as it just requires undoing six torx screws and a single Philips head. With the top cover removed, you can access the computer's memory slots as well as the M.2 NVMe and SATA drives.

BENCHMARK TALES

The 'discrete-class' Radeon RX Vega graphics are every bit as impressive as Intel and AMD promised. We can play all our favourite games, including *Far Cry 5* and *Warhammer: Vermintide 2*, at a steady 60 frames per second (fps) with high-quality graphical settings and a 1080p resolution.

Even more impressive is that the little PC holds it

own through *Overwatch* and *Hitman* at 1440p with HDR active on a Samsung CHG70 QLED gaming monitor. The only title to give us some measurable difficulty is *Assassin's Creed Origins*, but it still runs at a completely playable 40fps with high quality settings and a 1080p resolution.

Outside of gaming, the Intel Hades Canyon NUC runs like a champ through all our regular web browsing and word processing, as well as our image and video editing needs. For those multi-monitor fans, the Intel Hades Canyon NUC can also drive up to six screens.

Compared to comparable notebook hardware in the 15-inch Microsoft Surface Book 2, the Intel NUC almost wins the complete race in both processor and graphically intensive tests. A full-on gaming laptop like the Dell Inspiron 15 7000 Gaming manages to close the gap a little better, but for

the most part the Hades Canyon stays on top.

Meanwhile, a gaming PC with actual desktop parts, like the ASUS ROG G20CI, proves to be tougher competition. While the NUC manages to score better in the processor tests, the integrated graphics just can't keep up with a Nvidia GTX 1080 – then again, neither could the AMD Radeon RX Vega 64.

THE PEAK OF NUC DESIGN

The Intel Hades Canyon NUC is the company's most impressive mini PC yet, capable of playing most modern games with ease and offering plenty of performance for everyday computing. And, that's all without the help of an external GPU, unlike the previous Skull Canyon NUC.

This is true high-end desktop computing on a single, standalone chip. Beyond this one device, it

represents a turning point for thin-and-light laptops like HP Spectre x360 15 and Dell XPS 15 2-in-1 to be just as powerful as full-on gaming laptops.

Although the Hades Canyon NUC might be expensive and require additional parts, you won't find another mini PC as powerful as this. The expansive array of ports and support for high-end internal components is equally as amazing, and it'll also make a near-perfect home theatre PC.

■ Kevin Lee

Verdict

Features
Performance
Value



An incredibly tiny and VR-capable gaming PC worthy of your attention and consideration.

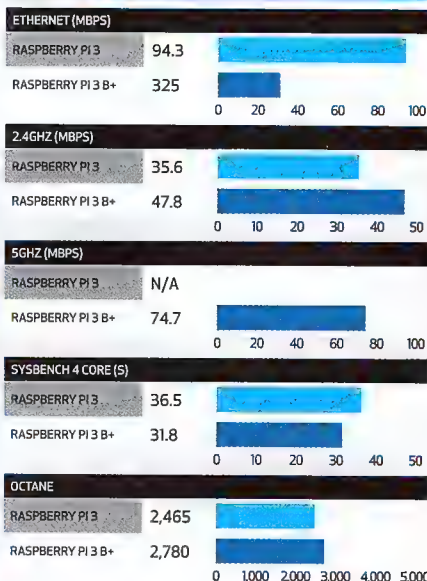




SINGLE-BOARD COMPUTER

#64 | WWW.RASPBERRYPI.ORG

LABS BENCHMARK RESULTS



Raspberry Pi 3 B+

Another slice of Pi to tuck into, and one that is incrementally better than the last.

Another Raspberry Pi! Will this be the fabled Raspberry Pi 4 offering USB 3.0, SATA, GTX 1080 GPU, octa-core CPU and 16GB of DDR4 RAM?

So let's first address the obvious questions. No, this isn't the Raspberry Pi 4 and no, it has none of those features. Rather, the Raspberry Pi 3+ is an incremental improvement of the Pi 3 B that gives us a little more power, and much better connectivity. This is not the first B+ board – that was the original B+ released in 2014 and saw the first board design morph into what has become the de facto standard board layout, often emulated, but so far unbeaten by its competitors.

INCREMENTAL UPDATE

Let's start with System on a Chip (SOC), which is a BCM2837B0 containing the CPU. Just like the Pi 3, we have an ARM Cortex A53 64-bit CPU, but now running at 1.4GHz, which is an

increase of 200MHz over the Pi 3. It's not a massive increase, but it helps to make Raspbian run a little bit smoother. In general operation Raspbian felt more responsive and it was a genuine pleasure to use, so that extra power really did the trick.

RAM remains the same at 1GB. That's enough for most Pi power users, but it would have been nice to see 2GB of RAM which is rapidly becoming the norm thanks to boards such as Asus Tinkerboard. We ran a sysbench test, computing prime numbers up to 10,000 using all four cores of the CPU. The Pi 3 B+ did this in 36.583 seconds, versus 45.7046 for the original Pi 3. A profound result – that's nearly 20 per cent quicker than the original Pi 3!

IMPROVED NETWORKING

With the Pi 3 in 2016 we saw the inclusion of onboard Wi-Fi and Bluetooth, and this has been further improved for the Pi 3+ with

Wi-Fi now offering 5GHz 802.11ac. This has a much higher throughput – theoretically up to 1.3Gbits per second – but in tests we found it to be 74Mbits/sec (9.25MB/s) versus the standard 802.11n speed of 47.8Mbits/sec (5.875MB/s).

Taking a feature from the Pi Zero W we find that the wireless antenna is the same design, a licensed feature from Proant AB. There's no connection for an external antenna. This new 5GHz Wi-Fi option works remarkably well and in our tests we were able to watch a 1,080p YouTube video with only a slight amount of buffering when it started to play.

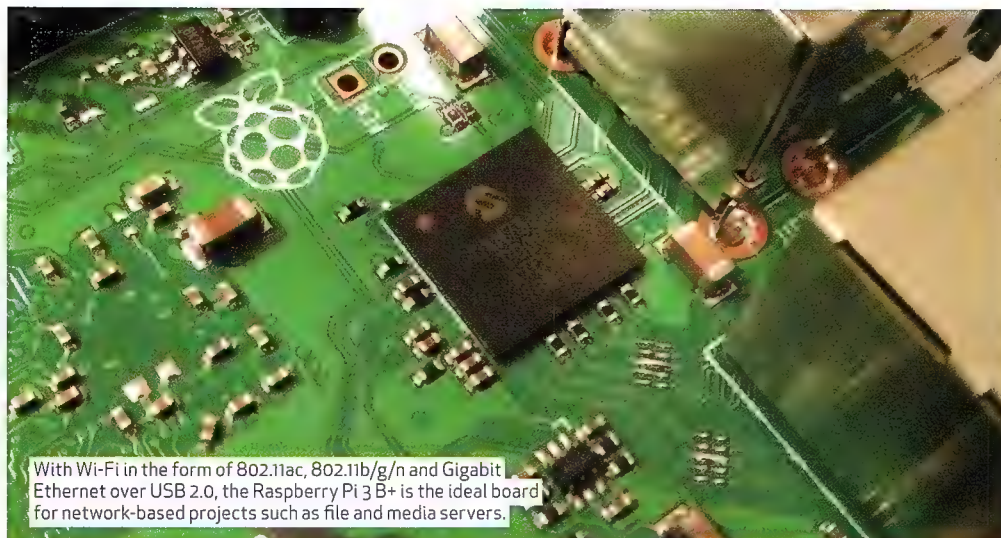
Another improvement is with Ethernet. On the previous models of Pi we have seen a LAN9512 and LAN9514 controller chip that offered USB 2.0 ports and an Ethernet connection. For the Pi 3 B+ we see the new LAN7515 providing Gigabit Ethernet over a USB 2.0 interface. So with this

new chip running the Ethernet at 325Mbits/sec (40.6MB/s) we see a vast improvement – over three times the performance – when compared to the previous Pi 3, which had a bandwidth of 94.3Mbits/sec (11.78MB/s).

When compared to the Asus Tinkerboard, which uses an RTL8211E chip for true Gigabit connectivity (in tests we recorded 939Mbits/s, which is 117.375MB/s), the Pi 3 B+ is still slow. However, for general operation and use as a home file server it's a welcome increase in performance that offers plenty of bandwidth for streaming files at truly reasonable speeds. Bluetooth is also improved to BLE 4.2.

POWER OVER ETHERNET

The now standard 40-pin GPIO (General Purpose Input Output) remains the same, ensuring compatibility with the many add-on boards available. We tested the



With Wi-Fi in the form of 802.11ac, 802.11b/g/n and Gigabit Ethernet over USB 2.0, the Raspberry Pi 3 B+ is the ideal board for network-based projects such as file and media servers.

GPIO using the traditional RPi.GPIO Python library as well as GPIO Zero and found that all was well, including the use of add-on boards.

Just next to the GPIO pins are four extra pins labelled PoE (Power over Ethernet), which enables the Pi 3+ to be powered and communicate using one cable. This will be via a future PoE HAT. But there arises one little problem. The placement of the PoE pins means that they'll be obscured by any HAT specification boards placed on the GPIO. We speculate that the new PoE HAT will have a pass-through GPIO connection, but at time of writing there's no information. The PoE pins introduce the possibility of some boards making direct contact with the pins, which risks shorting components on the underside of boards. We advise checking your clearance before applying the power.

LEGACY PORTS

The Pi 3 B+ has the same ports as those found on the Pi 3 (HDMI, an official camera/display and a combined audio/video jack). No changes are made to the USB, either with four USB 2.0 ports offering enough connectivity for most users. Power is provided via the micro USB port and the official 5V 2.5A power supply is recommended.

At idle the Pi 3 B+ can pull around 530mA, but when watching a YouTube video in fullscreen this went up to

1A and we saw the dreaded lightning bolt icon on the desktop, indicating that our power source was inadequate. So we swapped to the official power supply, which thankfully solved the issue.

BETTER THERMALS

There's no denying that the Pi 3 could run a little hot. In fact we ran ours under stress, playing a YouTube video, flying around in *Minecraft* and a stress test computing prime numbers with sysbench, and the device reached 81.1°C. But with the Pi 3 B+ the highest temp we found was 67.1°C. All down to a new thermal cap to help dissipate heat and makes it ideal for use as a home media player, which is typically placed inside a case.

DESKTOP REPLACEMENT

For some users the Raspberry Pi, rather than being a platform for making/hacking, has been seen as a low-cost alternative, general-purpose computer. In previous versions this was possible if a few compromises were made, chiefly web browsing. But since Chromium was chosen as the default browser, we've seen an increase in processing power and now with the wired/wireless connectivity improvements, especially in the Pi 3, we now have a Raspberry Pi that could be quite easily used as a replacement to an older computer. Not forgetting, of

course, the added bonus that it runs quietly and uses far less power than a laptop or desktop computer.

The Raspberry Pi 3 B+ may not be the 'Raspberry Pi 4' but it was never really intended to be. Instead, it's an incremental update that provides users with refinements to the existing package. The improved CPU power is a welcome boost, but the biggest improvement is networking. Providing something better than the 100Mbps found in the older models via Gigabit over USB2 will help users eager to build networked devices, and for those with 802.11ac routers the 5GHz Wi-Fi is an excellent compromise of speed and portability.

The Raspberry Pi 3 B+ deserves a lot of love. It brings new features and improvements while remaining true to its roots. The GPIO is the same as all previous models (ironically the original B+ onwards), but do take into consideration the PoE pins and make sure that your board isn't touching them.

The price of the Raspberry Pi 3 B+ mirrors that of the original Pi 3, so if you're new to the Pi then this is the model to purchase. Existing Pi 3 owners may need to justify the purchase, though.

In sum, this is a great board; a worthy successor to the Pi 3, and a step along the path to what we hope to see in the Raspberry Pi 4.

■ Les Pounder

Family resemblance

When the Raspberry Pi first appeared in 2012, the unique form factor suffered one complaint: poor placement of screw holes. In fact the first version of the board had no screw holes.

Screw holes are important because add-on boards for the Raspberry Pi came in all sorts of shapes and sizes, causing a few issues. For example, the Pibrella board was designed for a 26-pin GPIO and it had a rubber foot to stop it shorting out on the HDMI port when pressed. What was needed was a standard connection, so with the Raspberry Pi B+ in 2014 we saw a 40-pin GPIO and screw holes added to the corners of the board. This offered a consistent mechanical point to which boards could be secured using M3 standoffs.

This new standard was part of the HAT (Hardware Attached on Top) which saw EEPROM chips that would talk with the new 40-pin GPIO and enable configuration of the board. This then became the de facto Pi form factor and subsequent model B boards have followed this layout, enabling a board designed to meet this standard to work across the range of Raspberry Pi.

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A slight increase in CPU power but lots of networking improvements means this Pi is a new classic.





TABLET

FROM \$469 (32GB) | WWW.APPLE.COM/AU

Apple iPad (9.7-inch, early 2018)

The most affordable iPad ever brings some brilliant upgrades.

The new iPad for 2018 is designed to achieve one thing: deliver the best of Apple's tablet efforts at a more affordable price. The cost is still higher than many other tablets out there but the new upgrades bridging the gap between a 'standard' slate and the more impressive iPad Pros.

The new iPad comes with a range of storage and connectivity options, with prices starting at \$469 for the 32GB Wi-Fi model, and the equivalent cellular version at \$200 more.

In the looks department, the metal back, the well-machined buttons, the home button at the base of the tablet with TouchID are all present and correct. The thickness of 7.5mm is actually 1.1mm thicker than the iPad Air 2s that emerged a couple of years ago, but Apple has greatly improved the speed and performance of its tablets in that time.

The screen is bright, with a resolution of 1,536 x 2,048 pixels and a pixel density of 264ppi. You could argue that it's a shame not to see HDR supported here but Apple is trying to keep the costs down. The same reasoning applies to OLED technology. And it's hard to criticise the display, especially as it can now work with the Pencil.

It's tough to work out whether the Apple Pencil is a genuinely innovative tool or not. We've been using it for a few years now, and have found that it's great for some things, but useless for others. It costs \$145, a third of the price of the iPad itself. It's really difficult to write legibly on them, too, due to the way the tip of the Pencil glides across the surface. Where the stylus does become worth the outlay is when you want to be artistic.

According to Apple, there are 200,000 apps on the App Store for educators and students, and teachers are

also getting access to Schoolwork and iTunes U, for course materials and the ability to set assignments and see how students are progressing. iWork suite is also collaborative and Pencil-friendly, plus there's 200GB of online iCloud storage for students (but not everyone else).

The new iPad has the A10 Fusion chip that powered the iPhone 7 and 7 Plus. That's combined with 2GB of RAM, so there's more than enough power here for nearly any task that most users will want to do. In our tests, it returned a similar single-core benchmarking score to the more powerful iPad Pro 10.5, and both devices' batteries lasted around 4.5 hours, running at full power.

It sounds obvious, but you'll need to know what you want the new iPad for before you can decide if it's for you. Apple has made a big deal about the new tablet's

classroom credentials, but in reality, most of the people who buy it will be those who want something to use on the commute and around the house.

If you're someone who's never owned an iPad before, or you're buying it for a relative who's always wanted a tablet, then you've come to the right place, and you should buy this one without question. However, if you've got an iPad Air 2, iPad Pro 9.7 or last year's iPad, there's not enough of an upgrade to make it worth purchasing... **Gareth Beavis**

Verdict

Features
Performance
Value



Packs in some useful upgrades to remain the top all-rounder tablet you can currently buy.





HYBRID STORAGE DEVICE

\$289 (FOR 118GB) | WWW.INTEL.COM.AU

Intel Optane SSD 800p 118GB

3D XPoint memory hits the mainstream.

Ten times the data density, 1,000 times faster, 1,000 times better endurance. All of this and more Intel claimed three years ago for its revolutionary 3D XPoint non-volatile memory tech, now branded Optane. Those claims were made in comparison to the non-volatile memory tech that dominates the storage industry, namely NAND flash memory.

Now we have our hands on Intel's first more-or-less mainstream SSD for PCs based on 3D XPoint, the Optane SSD 800p. But what's this? Sequential reads of 1,450MB/s? Writes of just 640MB/s? And check out the IOPS, too. Intel rates its new Optane drive at just 250K read IOPS and 140K for writes. Far from being 1,000 times faster than a NAND SSD, all those figures are significantly slower. What's going on? The short answer is that it's complicated.

At launch, it's only available in two configurations: 58GB and 118GB. Launch pricing is \$179 for the smaller drive and \$289 for the 118GB drive tested here (which formats down to 110GB). Expensive, small and slow, you may be thinking. In many of our benchmarks, the 800p is unremarkable by conventional SSD standards, and a major letdown given the hype that initially accompanied 3D XPoint. Sequential throughput is pretty much in line with Intel's claims, and thus miles off the fastest NAND-based SSDs.

Granted, Intel has gone with a dual-lane PCI Express interface for the 800p, which puts a cap on peak transfer performance compared to high-end NAND drives with quad-lane interfaces, but that's clearly not what is holding back the 800p's sequential write performance, which clocks in at a maximum of 650MB/s

in ATTO Disk Benchmark. That's barely any faster than a SATA SSD.

However, CrystalDisk Mark's 4K random access metrics hint at the 800p's greater potential. The 800p registers 229MB/s for reads and 176MB/s for writes. Those figures are much faster than the current gold standard of NAND SSDs – the Samsung 960 Pro – can muster. Broadly speaking, then, the focus for this drive is on low latency and low queue-depth performance, not peak throughput.

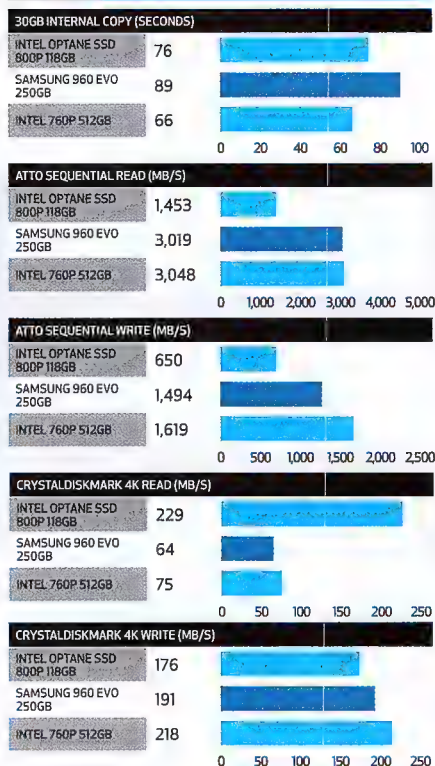
Intel says that the 800p is 4–5 times faster to respond at short queue depths of one and two compared to a NAND-based SSD. (It's at much deeper queue depths of up to 32 where those NAND drives deliver their fastest 4K random access performance.) What's more, Intel reckons it's those shorter queue depths that most determine the performance of typical

client PC workloads. Intel also says performance is maintained regardless of how full the drive is, and rates the 800p for 365TB of writes, which is incredibly high for such a small drive.

All told, the new Intel Optane SSD 800p is a bit of a mixed bag. This is, very likely, the most responsive mainstream SSD you can buy. It's also quite possibly the most robust. But it's not the fastest. 3D XPoint could well still be the future of PC storage, but for now, it feels like a beta technology.

■ Jeremy Laird

LABS BENCHMARK RESULTS



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

While relatively affordable for an Optane drive, it boasts poor sequential performance.





PROFESSIONAL LAPTOP

FROM \$2,899 | WWW.GIGABYTE.COM.AU

Gigabyte Aero 15 v8 (2018)

Gaming-grade speed in a pro form factor.

Gigabyte's Aero range of laptops has attempted to bring premium gaming components to the ultrabook form factor, and this newly-refreshed Aero is no different. Combining a 15.6-inch Pantone colour-calibrated screen, full-sized keyboard, dedicated Nvidia GTX 1060 GPU and a generous 94Wh Li-Ion battery within a slim 35.6 x 25 x 1.9cm chassis is an impressive feat. Combine this with one of Intel's new high-end 8th-gen mobile CPUs, 16GB of DDR4 RAM and a 512GB SSD and you have a cutting edge gaming PC that slyly takes the shape of a professional ultrabook.

This has invariably lead to some design choices that will be divisive – like dropping the web cam to the bottom of the screen, and giving the keyboard a fractionally off-centre and slightly crowded feel. On the

whole, though, these compromises seem to have been carefully considered and ultimately end up as minor grievances.

Taking prime position at the top of the Aero 15 is that display, which looks great in its near bezel-less frame. While the entry-level configuration we tested was only an IPS LCD at 1,920 x 1,080-pixel resolution, it's upped the refresh rate from last year's model from 60Hz to 144Hz.

Packing the first six-core mobile CPU we've seen from Intel – one of the company's new high-end 8th-gen Core i chips – the Aero 15 cut a swathe through our CPU-intensive benchmarks. The raw CPU scores from Cinebench's R15 benchmark show that, on single-core tests, this laptop's new Core i7-8750H CPU scores only a little better than its i7-7700HQ predecessor in the ASUS ROG Zephyrus, with Gigabyte getting 156 to

ASUS's 149. This 5% per-core boost translates into a 17.4% overall boost in multi-threaded CPU benchmarks when using Windows' 'Balanced' power mode.

However, this CPU can be pushed considerably further by putting the Aero 15 into Performance power mode, which puts it 53.5% ahead of the ASUS, and fairly close to desktop performance levels. In general work and home tasks, the Aero achieves similarly impressive results – it powers through tasks better than any laptop we've tested with 16GB of RAM.

While the Aero 15 has generous GPU power for a professional ultraportable, the Nvidia GeForce GTX 1060 model is middle-of-the-road when it comes to performance against today's gaming laptops. It'll still get close to, if not more than, 60fps on most early-2017 games using Ultra settings at 1080p, albeit with a few exceptions. Turn down those

graphical settings a little, however, and you'll be able to really put that 144Hz screen to use, with less-demanding titles often pumping out +100fps.

The Aero gets over 7 hours of movie playback when in 'Performance' mode. The updated model does sacrifice the 3,000/1,500MB/s NVMe SSD from last year's model for a slower 500MB/s SATA SSD, but this is the device's only real step backwards – and it's a largely inconsequential one.

Joel Burgess

Verdict

Features
Performance
Value

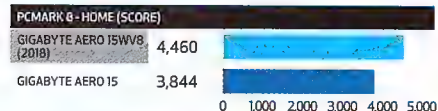


Packs powerful components into a slim 14-inch chassis for a neat balance of work and play.

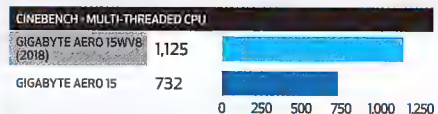
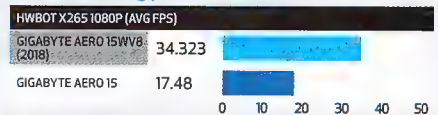


LABS BENCHMARK RESULTS

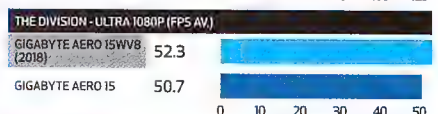
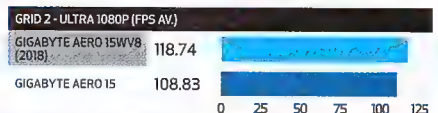
General performance



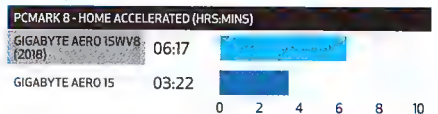
Media encoding performance



Gaming performance



Battery life





GAMING LAPTOP

\$1,998 | WWW.DELL.COM/AU

Dell Inspiron 15 7000 Gaming (7577)

Can Dell's price-conscious 15-inch gaming laptop inspire budget gaming buyers?

On paper, Dell's latest Inspiron 15 is the ideal configuration for those interested in a well-rounded gaming laptop that doesn't cost too much. With a 15.6-inch Full HD screen, Core i7-7700HQ CPU, GTX 1060 GPU, 16GB of RAM, a smaller 256GB NVMe SSD and a roomy 1TB HDD, a lot of the necessary boxes have been ticked, but without going overboard. If we then consider that all this is packaged in a 38.9 x 27.5 x 2.5cm form factor that offers ample room for the device's mobile components and covers off any space-related thermal pressures, you have a recipe for a gaming laptop that can be highly competitive on price.

This configuration's RRP is \$2,299 and while it isn't available at a wide range of stores, we have seen it for as little as \$1,998. It also comes in a variation with 8GB of RAM that jettisons the 1TB

HDD, but this inexplicable storage design choice renders it largely useless as a gaming laptop, so we'd suggest avoiding the \$400 saving, unless you're OK to permanently sticky tape a portable hard drive to it.

The keyboard surround and outer shell of the Inspiron is subtle for a gaming device, placated by a space-grey metal casing that shows only hints of its gaming tendencies through a jellybean red outer-shell logo and soft maroon key-cap lettering. While the keys are a little smaller than competitors' models, the compact shape does allow a far more uniform layout that won't trip anyone up. And although the actual travel distance feels shallow, the responsiveness and soft key feel make it a nice device to type on. Sadly, the same can't be said about the trackpad, which feels more coarse than the metal casing surrounding it.

While the Inspiron 15 7000 might be considered in the budget category of gaming laptops, it's got some powerful components that'll outperform many pro and general use devices. The Intel Core i7-7700HQ CPU was one of the most powerful laptop chips available in 2017 and, though it's now been superseded by Intel's latest 8th-gen mobile processors, it's still up-there in terms of performance. The device's benchmark scores match up with other similarly specced laptop units on media encoding and general home- and work-related tasks – getting 4,033 on PCMark 8's Home accelerated benchmark – similar to devices like Acer's Helios 300, Gigabyte's Sabre Pro 15 and HP's Omen 15.

The Inspiron gets above 30fps on Ultra settings in all the 2017 games we benchmarked (with most closer to the 50fps mark)

and it powers through older titles like GRID 2, netting a 111fps average on Ultra.

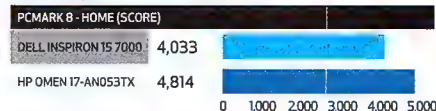
The Inspiron 15 7000 hasn't been kitted out with the biggest battery, even by gaming laptop standards, lasting a mere 1 hour and 23 minutes in PCMark 8's Home Battery (accelerated) benchmark, so don't leave home without the power cord. It also weighs 2.65kg.

On balance then, this is a solid offering, but there are a number of devices that offer a very similar layout for the same price or less.

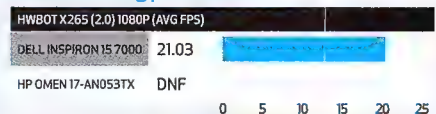
Joel Burgess

LABS BENCHMARK RESULTS

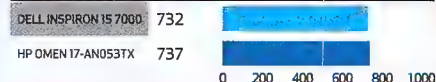
General performance



Media encoding performance



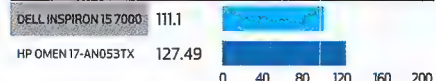
CINEBENCH - MULTI-THREADED CPU



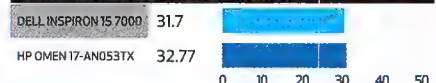
Gaming performance



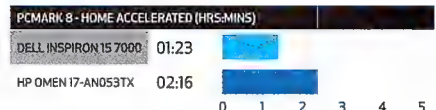
GRID 2 - ULTRA 1080P (FPS AV)



GHOST RECON WILDLANDS - ULTRA 1080P (FPS AV)



Battery life



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A well rounded, reasonably priced gaming laptop, but it doesn't get any awards for originality.





4K MONITOR

\$1,299 | WWW.LG.COM/AU

LG 27UD88-W

A pleasing 4K IPS panel... at a price.

We live in an age of ubiquitous technological plenty.

Powerful computers in our pockets, near-enough super-computers on our desktops, always-on super-speed connectivity—it's all available, and all quite affordable. But there are one or two areas where compromises must be made at almost any money.

One of those is PC monitors. No matter how much money you throw at a screen, you can't have it all. Take LG's new 27UD88-W. It's pricey, and it measures just 27 inches across, is limited to 60Hz refresh, and doesn't support HDR. That's partly explained by the signature feature: a UHD or 4K pixel grid. For now, the combination of 4K with high refresh, HDR and a really large panel isn't available. In fact, the combo of just 4K and high refresh is still around the corner. So what has LG rustled up to justify a fairly stiff sticker price for such a modestly

proportioned panel? After all, 27-inch 4K monitors can be had for around \$650.

For starters, the 27UD88 packs a quality IPS panel, while cheap 4K monitors make do with TN tech (inferior colours, contrast and viewing angles). The LG also offers support for 99% of the sRGB colour space and 10-bit colour depth, though the latter is thanks to dithering, rather than native support. The panel itself is 8 bits per channel.

Another nifty feature is the upstream USB Type-C port with DisplayPort alternate mode capability. The idea here is to hook up a laptop and do everything over a single cable. That includes driving the display, charging the laptop, and enabling the monitor's USB hub for connecting peripherals. If using a laptop as your main rig and hooking it up to external displays is your thing, this LG promises to make docking super-simple.

You also get support for AMD's FreeSync tech for

smoother gaming and no screen tearing. Just remember that requires an AMD graphics board. Tying it all together is LG's best effort at a premium look: a brushed metal effect stand (actually plastic), a moderately trendy screen enclosure in white plastic, and fairly thin bezels.

While the 27-inch proportions may be modest, the upside in combination with the 4K resolution is a nice, tight pixel grid. That means lots of detail, and nice sharp fonts. More generally, the panel has a relatively subdued character. It's more natural than punchy. Moreover, the standard factory calibration is nicely judged, with ample detail in black and white scales, and perfectly smooth gradients.

It also gets a brownie point for delivering decent contrast for this class of panel. True, a VA panel typically offers deeper blacks, but the 27UD88 doesn't suffer from an excess of light bleed.

As for the USB Type-C with alternate DisplayPort mode, that failed to function with our Apple MacBook with its single USB-C port. Whether that reflects a problem with the monitor or MacBook was impossible to determine. Our advice would be a little Googling to search for any issues specific to your laptop.

The overall upshot is a pleasing, fairly versatile monitor. It doesn't excel in any area. It's not a proper professional screen, nor an obvious choice for gaming. But it doesn't do anything badly, and it does a lot of things well—at a price.

■ Jeremy Laird

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

While expensive for a 27-inch monitor, it does boast a quality IPS panel and creative features.





GAMING MOUSE

\$80 | WWW.STEELSERIES.COM

SteelSeries Rival 600

A Rival with no real rival.

Balance, as we all know, is vitally important. Without it, we wouldn't have Segway polo, giant Jenga, or standing up. Does the world of mousing really need a big emphasis on balance, though? Does it need 256 possible levels of side-to-side balance adjustment?

Science has not advanced far enough to tell, but that's what SteelSeries is offering with the Rival 600: a series of eight 4g weights, with eight possible positions to place them, four on each lateral edge of the mouse. Pull them all out, and the mouse is light and skippy; stuff them all below the detachable side panels, and it's, predictably, 32g heavier, with a weightier glide.

We preferred the Rival 600 fully loaded, because it's not only made for balance; it's meant to be ultra-accurate, too. Tracking error when even slightly lifted is basically zero, thanks to the combination of the same TrueMove 3 sensor we've seen in SteelSeries's Sensei

mouse and a secondary lift sensor, which can be set to trigger at a custom height. It's remarkable and a little unnerving, but there's no cursor drift whatsoever. If you end up pointing at something you didn't want to point at, that's on you.

SteelSeries has not forgotten the aesthetic side of things. There's a good swathe of RGB lighting, compatible with SteelSeries's excellent Prism lighting system. Everything's beautifully coated in that grease-magnet soft plastic finish that tends to wear away and get sticky after a few years' solid use (so bear that in mind). The cable's not braided, but it's replaceable, so we won't dock it any points. ■ Alex Cox

Verdict

Great feel and custom balancing makes this very accurate. It's a shame it's so expensive, though.



LAPTOP BACKPACK

\$180 | THENORTHFACE.COM.AU

The North Face Iron Peak

Named after mountains, built for the city.

After loving the rugged and functional Recon, and then the beautifully designed (yet somewhat quirky) Access pack a little while ago, we've now dumped our day-to-day cartage into the The North Face's latest commuter offering, the Iron Peak.

And the conclusion we've arrived at is that the brains over at The North Face's product development department really do kinda know what they're doing.

Crafted from 210D Cordura ripstop nylon, the Iron Peak features one primary 28L cavity for the bulk of your carry. Touted as suitable for 15in laptops, we actually had no trouble sneaking in our 17-inch MacBook Pro dinosaur. Just in front of the laptop pocket is the organisation section, featuring sub-pockets of varying sizes for your miscellany, alongside a fleece-lined slot for a tablet. We just liked putting our hands in it cause it feels so delicious.

The outside of the Iron Peak features a single quick access zippered – and again delightfully lined – pocket for your phone/glasses/hands, as well as stretchy water bottle pockets flanking each side.

Loaded up and two-strapping, the Iron Peak carries really well. It sits surprisingly high and tight to the body given its length, which keeps it out of the way of your back-end action-station during those quick platform changes or a cycle commute. Weirdly, comfort actually increases the more stuff you cram into it. That's largely due to the fantastic back panel, spine channel and injection-molded straps. It'll be a tough task to top this as a day-to-day carrier.

■ Troy Coleman

Verdict

A 15-inch laptop backpack built for commuter comfort with more than enough room for all your crap.





PC CASE

\$99 | WWW.COOLERMASTER.COM

Cooler Master MasterBox Lite 5 RGB

Meet the new budget blueprint.

It's far too easy to get caught up in the razzmatazz of full-sized premium cases and bespoke custom towers. Those rectangular boxes that pack every innovative feature around into their voluptuously carved forms appear before us like sirens. Their enticing figures draw us closer, before the reality sets in. Sure, they have their purpose, and the market is certainly there for those who can afford such luxury in their computing lives, but those triple-digit transactions are often an unnecessary indulgence.

The flagships may have better margins and the most advanced feature sets, but it's the sub-\$150 boxes — capable of distilling those heavenly attributes and condensing them down into a package that's both appealing and affordable — that ultimately win the war.

The MasterBox Lite 5 RGB is one of those offerings: the culmination of a desire to produce an affordable, market-dominating chassis, with all of Cooler Master's latest and greatest design touches trimmed to suit a more down-to-earth audience. This is budget done well.

A quick glance over the chassis soon reveals which corners have been cut to make form fit function, yet Cooler Master has done this without impacting the end user in any major manner. The transparent front panel is made of a more affordable plastic polymer, not glass. The dust filters, although small, are intuitively placed to ensure maximum coverage of air intake. The hard drive cage, bottom-mounted below the PSU cover, is non-removable and pop-riveted into position. There's support for four 2.5-inch SSD mounts, with only one bracket

included. And a tempered glass side panel is securely fixed in place by a bottom-mounted hinge and just two thumb screws across the top. The MasterBox Lite is a balance between feature and price.

That tempered glass and PSU cover impressed us, as did the support for up to a 360mm AIO in the front, the three included RGB front fans, the ability to rear-mount the 2.5-inch SSD and the included white or red accents, which you can swap out on the front panel. Couple all that with the stellar price tag, and we're looking at a new budget favourite.

One flaw, however, stems from the material used. Unfortunately, the plain black steel used across the exterior and interior of the chassis feels thin, and a little lackluster under the thumb. And as we've seen, the same material used in cases for the last eight years

or so, we just wish there was a touch more effort used on the finish, or something different entirely. But as that's our only sticking point, we'll let it slide.

Cooler Master's MasterBox Lite 5 RGB is a phenomenally priced budget box for any builder looking to construct a modern machine in a case that plays like a flagship. Its feature set is inclusive, its design aesthetically stunning, and its price the perfect balance. What more can be said?

■ Zak Storey

Verdict

Features
Performance
Value



With an incredible design and great price point, it's a great budget box for builders.



software

» APPS FOR ALL THE PLATFORMS



Iolo System Mechanic Pro

Promises a faster, more secure Windows PC.

\$49.95 | WWW.IOLO.COM

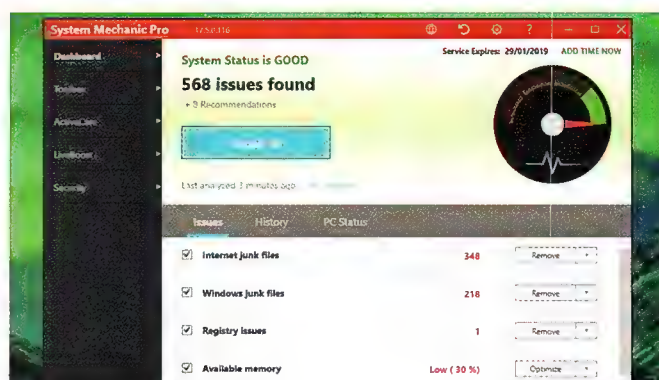


Iolo System Mechanic Pro (SMP) claims to be one-stop tool for PC optimisation, packed with all the tools you could possibly want for keeping Windows running smoothly. And unlike many system optimisation tools, nothing about SMP is opaque or confusing. All your options are clearly labelled, with full descriptions of their purpose and details about what the effect of deleting or optimising the item in question will be. Alongside those performance tune-up features, SMP also includes impressive protection from malware, with behavioural analysis to pick up threats even if they haven't yet been catalogued in Iolo's extensive database.

If you just want to give your PC a quick tuneup, the Dashboard might be all you need. The software scans for junk files, broken or missing registry entries and unnecessary browser cookies. The scanning process is fast, and once it's complete, you can fix all identified problems with just one click. After the initial scan, you can generally rely on the app's ActiveCare tool to carry out this regular maintenance for you whenever your PC is idle.

Things get more interesting when you begin exploring SMP's Toolbox. This includes a combination of tools unique to System Mechanic, plus a few convenient links to the best of Windows' own utilities, saving you the need to trawl through the Control Panel.

The excellent Startup Manager is a huge cut above the one included with most other Windows tuneup applications. Each program listed includes a rating from Iolo's community



to help you decide whether to prevent it running at startup for faster boot times.

However, the standout feature has to be its superb malware scanner. This lets you check your entire system, a specific folder (particularly handy for scanning your Downloads folder) or just an individual file. The malware definitions are updated regularly, and there's sophisticated behavioural analysis to pick up newly emerging threats, as we mentioned above. SMP doesn't just block malware either – it can also remove it thoroughly if your PC is already infected.

In short, System Mechanic Pro makes for a great toolkit for fixing many PC ails. **Cat Ellis**

Hiri

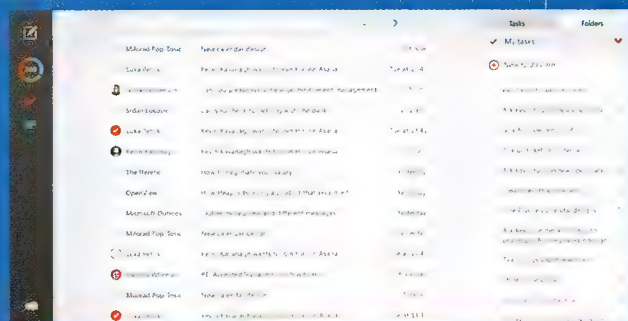
Ready or not, Hiri come.

US\$39 PER YEAR | WWW.HIRI.COM/TECHRADAR



Emails rarely need an instant reply [Ahem? — Ed], but it's easy to fall into the trap of opening your inbox whenever a pop-up notification appears. Hiri solves this problem by applying a time-management approach to email that encourages you to do them in batches, with a dashboard that tells you how many new messages you've received alongside a timer telling you how long to wait before reading them.

The program offers two inbox views: Unified Inbox, which displays all messages regardless of status, and Inbox Zero, which encourages you to categorise emails. Hiri uses 'Action' and 'FYI' fields instead of the usual 'To' and 'CC'. These perform the same function if the recipient uses a different email client, but if they have Hiri, your messages will be automatically sorted into those different folders, making them easier to prioritise. Hiri works with Microsoft Exchange, Outlook and



Hotmail accounts (and support for Gmail is reportedly on the way) and you can currently use the full app for free by following the link from our online sister publication, TechRadar, provided above. It's worth noting that this free version does include an eight-word Hiri watermark message that's added to the end of your email signature, but if you want to give it a try, that's well worth it. **Cat Ellis**



Mac » APPS

Parallels Toolbox

Tools to fill in macOS's gaps.

FREE TRIAL, \$27.99 ANNUALLY | PARALLELS.COM



Toolbox is a disparate collection of tools that are accessible via a menu bar icon. Click this and a collection of large icons with descriptive names make it easy to choose from the tools on offer – now numbering more than 30.

The tools are designed to plug the gaps in macOS, and range from Download Video (drag and drop links from YouTube and the like) to adding a menu bar icon for swiftly switching between different resolutions.

The last two major updates to Toolbox have added six new tools: Find Duplicates, Make GIF, Clean Drive, Free

Memory, Resize Image and Screenshot Page. Most are self-explanatory – Screenshot Page is designed for capturing long web pages as a single image in your browser.

The latest update also improves existing tools, and it's now possible to assign keyboard shortcuts to favourite tools. This is a little awkward – there's no prompt to warn you that a key combo isn't available; the shortcut simply doesn't appear.

Another less welcome development is that Parallels has doubled the cost of Toolbox. So what should be a triumphant update is spoiled by the price rise. **Nick Peers**

Tidy Up 5

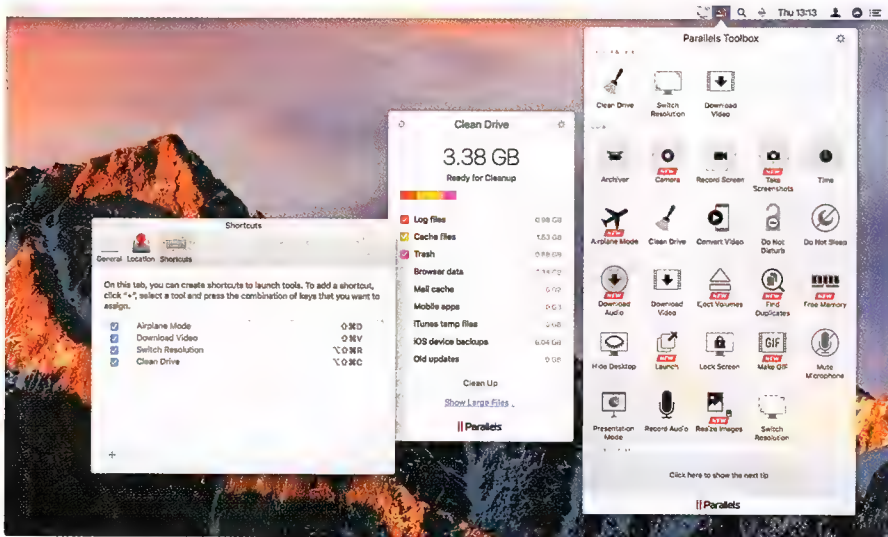
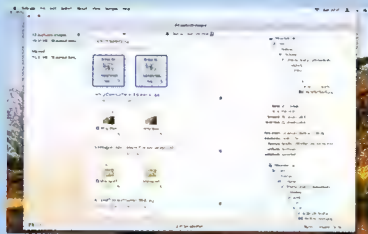
Clean up your Mac's files.

FROM US\$28.99
HYPERBOLICSOFTWARE.COM



Tidy Up 5 aims to keep your Mac clear of duplicate and unnecessary files by finding such files and making them easier to delete. It does so from a gorgeous interface, with smoothly animated transitions, and honest information about why a search is taking time. There are two modes: Simple image search finds pictures that are identical; in Advanced mode you can hone in on date, location, even camera used. Searches are quite quick. When done, Tidy Up provides detailed suggestions for removal, showing the path to each file with previews.

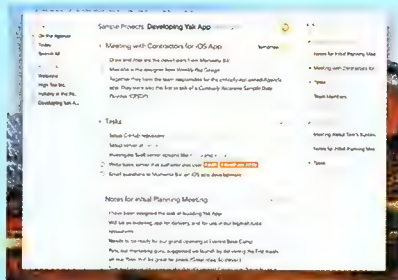
The problem isn't what it does, but the damage you could do with it. It doesn't remove duplicate images in Photos, but marks them for later removal. It will happily remove files from Time Machine backups, which can make them permanently unusable, and it can wreak havoc on apps too. It's a great housekeeping tool, but use with caution! **Howard Oakley**



Agenda

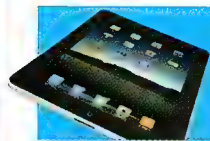
Note taking, reimagined.

FREE WITH IAP | AGENDA.COM



Note-taking apps aren't great at keeping tabs on when entries took place, while calendar apps focus strictly on date and time, with little regard to other details. Agenda bridges this divide, adding a project-based workflow to make things unique. This approach comes in handy for linking notes to specific events. The refined interface is designed around your agenda, with a collapsible pane to view upcoming events and jump directly to related notes; you can also search across all projects at once, filtering by date range, people or tag. Sample projects do a good job acclimating new users, and you can import existing

Markdown or Apple Notes to pick up where you left off. New notes offer basic text styles and formatting (lists, indentations), but you can't change font or text size. The lack of an iOS companion app or collaboration features are the biggest limitations, but developers say the former is coming soon; notes can be synced with other Macs on the same iCloud account, however. While Agenda is free, premium features are worth paying for, since any premium features added over 12 months are unlocked forever. **JR Bookwalter**



App Store » iOS APPS

MindNode 5

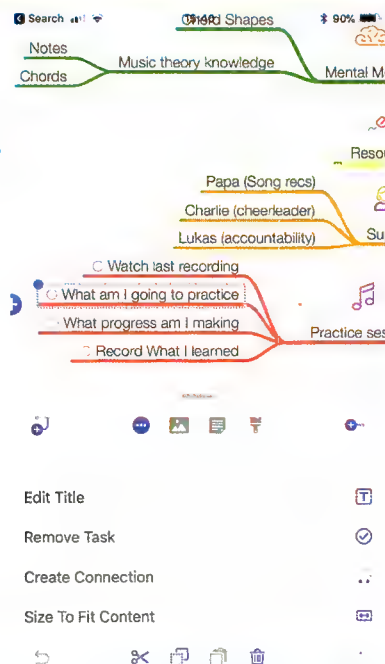
Map out your ideas with this superb productivity tool.

FREE WITH IAP | MINDNODE.COM



You've probably made a mind map before – the end result often ends up looking like an angry mutant spider. Software can bring some sanity to such creations, as earlier versions ably proved. MindNode 5 offers Quick Entry input. Available from within the app or a Today View widget, the feature has you make a bullet-point list. When you're done, MindNode converts your ideas into a diagram. This is a perfect way to start, rather than fiddling around constructing individual nodes when your brain's firing on all cylinders.

MindNode wants you to think more about content and less about the app itself. This is evident in the new panel structure. At the top left, three buttons provide fast access to your documents, sharing and an outline. Elsewhere, what was previously a fixed sidebar on iPad becomes a floating dynamic panel across all devices. Initially, its context-sensitive options disarm, but MindNode always gives you logical settings for whatever's selected. Everywhere you look, MindNode 5 comes across like an app that's been carefully considered. Then there are the iOS 11 niceties that you'd expect, such as Files support, and drag and drop – especially handy to quickly get images and text into a mind map. In short, this update propels the app to the very top of the iOS productivity pile. **Craig Grannell**



WebComics – update daily

Get your manga fix.

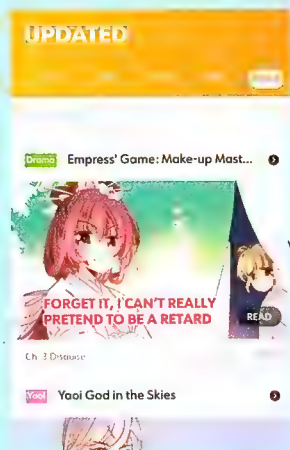
FREE | SIDEWALKGROUP.COM



Disclaimer:
There is some
mature content
on offer here, so

be sensible. 'WebComics – update daily' (you won't find it in the App Store without typing out the whole name) is an easy-to-navigate app, allowing you to absorb a whole swathe of online comics (manga) for free and without ads. Search the featured section for popular titles, head to Categories to sort by genre or keyword (romance, action, comedy, fantasy and so on), or head to the updated section for a selection of comics that are hot off the press. We glanced through a few different titles and were actually quite impressed with the quality of art on show here. This isn't a deviantART-style hub where there are dozens of amateurs for each professional artist. No. These comics are all fully coloured, shaded and translated. Sure, some of the translations are a bit off, but you'd be familiar with that if anime and manga is your thing. You can subscribe to titles, pinning them to your 'Mine' section, which also includes a history tab (so you'll never forget which comic you particularly enjoyed last week), and also a Comments section – because this app also offers a social aspect, allowing readers to leave mostly appreciative comments on titles and chapters. Worth checking out for fans of manga.

Carmel Sealey



PhotoPills

A must-have for photographers.

\$14.99 | PHOTOPILLS.COM



If you're any kind of photographer, ignore the price, buy this app now.

It's like a Swiss Army knife, giving committed snappers a whole array of tools to help plan, visualise and execute images. If you're adding an ND filter to your camera and want to calculate what your shutter speed should be to get the correct exposure, there's a page for that. Want to calculate your lens' depth of field? There's a page for that, too. Open the Planner and set the map to any location on Earth and PhotoPills will show you where sunlight is currently coming from, where it will be at the beginning of the golden hour, and where the moon will rise. Better yet, you can move the map around and see what the light will be there. There's a Milky Way calculator, allowing you to see where the Galactic Center will be, and at what angle. There's even an Augmented Reality mode, using your device's camera and overlaying where the Milky Way will be in the future. The learning curve is steep. In particular, if you're not comfortable with celestial terms such as azimuth, astronomical twilight and Galactic Center, prepare to invest a bit of time in the developer's superb YouTube tutorials. But once you've learned the ropes, you'll never go back to manual methods. Invest some time to learn it and this versatile toolbox app will quickly prove indispensable. **Dave Stevenson**





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The Independent UK



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Inkl

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The Inkl service has been around for a while. Essentially a platform for global news outlets, Inkl curates stories from reputable sources into one place and filters them into themes and topics. It's part RSS feed, part caped crusader, as Inkl recognises the value in actually paying for news rather than relying on a race-to-the-bottom, advertising-supported system.

You pick your topics and news sources from an impressive (but not yet comprehensive) list, and watch as your feed becomes populated with the news. It encourages discovery, presenting alternate points of view from competing articles and directs you to other topics, or subscribing to a theme to find out more. You still have the power to cull the sources you don't want to hear from, too. The first 30 days are free, with a caveat as more premium outlets like The Wall Street Journal are locked away behind a paywall, and the cost to access them initially seems steep. If you balk at paying 10c per article, there is a subscription model for \$15/month, or \$25/month for as much as you like. For the money you get a clean interface, with the Inkl app acting as a skin and formats all news to look like it was published on the Inkl site. (You can visit the original site if you wish.) Crucially, it cuts the advertising, it kills the clickbait, and tabloid trash and that is glorious. **Paul Taylor**

Gesture Control

Give your Android some iPhone X flavour with a gesture bar.

FREE WITH IAP | TINYURL.COM/TLA76GC



For better or worse, the iPhone X has had some deep influences on the Android phone market, so it stands to reason that some of its software mechanisms are making their way to the Android platform, as well as its hardware features. With Gesture Control, you can place a control bar at the base of your phone's display that allows you access to a variety of customisable functions via directional swiping, akin to the iPhone X. This works well on handsets that have lost their home and navigational buttons, whether it be by design or malfunction, as it allows for a surprising amount of control while sacrificing minimal screen real estate. You can customise the bar to a great degree — size, opacity, colour, sensitivity — but some advanced features are hidden behind a paywall, such as launching applications and 'tapping' gestures. For those handsets already sporting customisable soft buttons, this app won't have much use, but if your buttons are broken or not to your liking, give these gestures a try. **Harry Domanski**

Whistle To Find My Phone

Just purse your lips, that's the thing!

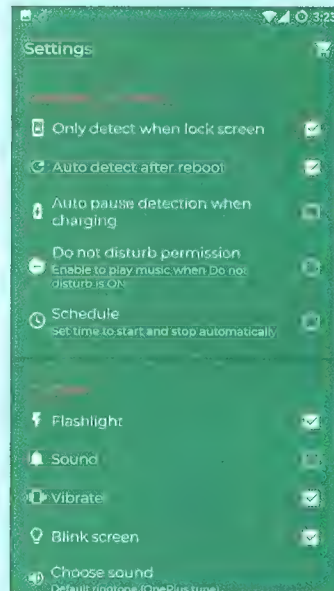
FREE WITH IAP | APPBRAIN.COM/DEV/REDTEAM/



There are a multitude of apps available that help you

find your phone via GPS, the most reliable of which likely come from the handset's manufacturer, but knowing which street your phone is on isn't very useful if you've lost it somewhere in your room. From the makers of Clap To My Find My Phone (which sucks by the way, don't even bother) comes Whistle To Find My Phone, an app that does what it says on the tin. You can adjust how your phone will respond to the whistle, activating flashlights, sounds,

vibrations, lighting up your display, and any combination of the aforementioned chaos. There are some genuinely useful settings such as scheduling your phone not to activate the detection at certain hours, certain days or when hooked up to a charger (because you can presumably find it when it's plugged into a wall) and the phone does seem to respond to a whistle fairly consistently. While the app seems reasonably inoffensive, the permissions required are a little invasive, your microphone will need to remain on, and you will be served a good amount of ads. **Harry Domanski**

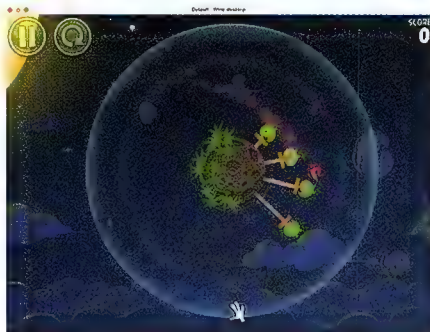




Wine

Software emulator.

FREE | WINEHQ.ORG



The story of running Windows binaries in Linux has been evolving ever since Wine first appeared. It was initially assumed that people would normally want to run business and productivity programs that weren't yet available for Linux natively, so Wine became known as a tool for launching Office or Photoshop outside Windows.

The recently revived Linspire distro, previously called Windows, included Wine as an out-of-the-box feature, although the developers later ditched it. Modern Wine versions cope with major Windows programs well and it's clear that the next goal is to bring high-profile Windows games to Linux. There are lots of closed issues regarding modern titles. Wine 3.3 features better gamepad support with its HID driver, an initial support for Vulkan as well as the new multisample textures support for Direct3D, plus the bleeding-edge Wine code from the Wine Staging project (github.com/wine-staging) to enjoy the latest graphics performance enhancements and extras, such as GTK3 themes support. The main Wine software has ditched the older DOS-related parts, meaning that, if you plan to run DOS programs in Linux, you're better off with Dosbox. Most .exe files will automatically run if they're associated with Wine, but if you click an app and nothing happens, be sure to run

`$ wine app.exe` from the and check the output. As usual, the

`$ winecfg` command is a door to the magic world of Wine's settings where you can change lots of performance and compatibility settings.

Alexander Tolstoy

Bleachbit

System cleaner.

FREE | [GITHUB.COM/BLEACHBIT/BLEACHBIT](https://github.com/bleachbit/bleachbit)

Many people either stick with one Linux distro or change things up from time to time, but use the same /home directory on a separate partition each time. These users will probably know what it's like to have lots of temporary files in their profile. Although you can always inspect and delete superfluous files by hand, there's a simple GUI tool for this side-effect known as Bleachbit.

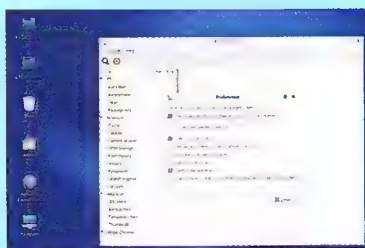
The idea behind this program is similar to what CCleaner does for Windows. Bleachbit has a simple interface and practically fool-proof, warning you about possible consequences when you activate certain levers and triggers on the left side of the window.

Bleachbit can also clean the Apt packages cache for the whole system and claw back some extra space on the root partition. The new 2.0 release features much-improved support for cleaning your Chrome and Chromium profiles (which tend to accumulate huge volumes of data after weeks of browsing), as well as a new feature for the secure deletion of SQLite databases. As before, Bleachbit is a perfect solution for cleaning up Firefox and Thunderbird caches, uninstalling unused localisation packages, and wiping out files such as Thumbs.db and .DS-Store.

You can also securely delete files with it. Bleachbit can be directed to shred files and overwrite free disk space with blank data in one pass, ensuring that it's impossible to recover data using well-known tools such as Photorec or Testdisk.

It should be the first choice for users who need to shred data securely, making them unrecoverable.

Alexander Tolstoy



Polo

File manager.

FREE | [GITHUB.COM/TEEJEE2008/POLO](https://github.com/teejee2008/polo)

Should you tire of either classic icon-view and dual-paned file managers, then check out Polo. It's a modern file manager for Linux, written in Vala and based on GTK3. It has a number of distinctive features that are well worth exploring.

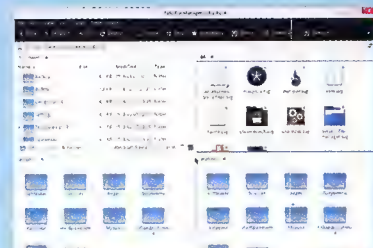
A style wizard offers you several useful layouts. You can use Polo with the 'extreme' style that results in a quad-pane setup combined with listviews, global pathbar and global statusbar. A dual-pane 'commander' mode is available, too.

We found Polo to be intuitive. For example, it features tabs, bookmarks, bars that indicate the amount of free space left on mounted drives, cloud storage support (this feature requires Rclone), a session manager, a built-in terminal panel and many other details that you'll come across sooner or later if you choose to install the program. Within the Context menu are quick links for mounting ISO files, writing to USB dongles, modifying PDF and graphic image files, and even managing instances of KVM virtual machines.

Polo feels like a well-built Swiss army knife, although the project is rapidly evolving and we expect it to become even more complete in the near future. The application has a distinctive design and after spending a bit of time using Polo, coming back to Nautilus was like alighting from a high-speed train and boarding carriages pulled by a steam engine. We think that Polo can easily become your main file manager, especially in a GTK3-based desktop environment.

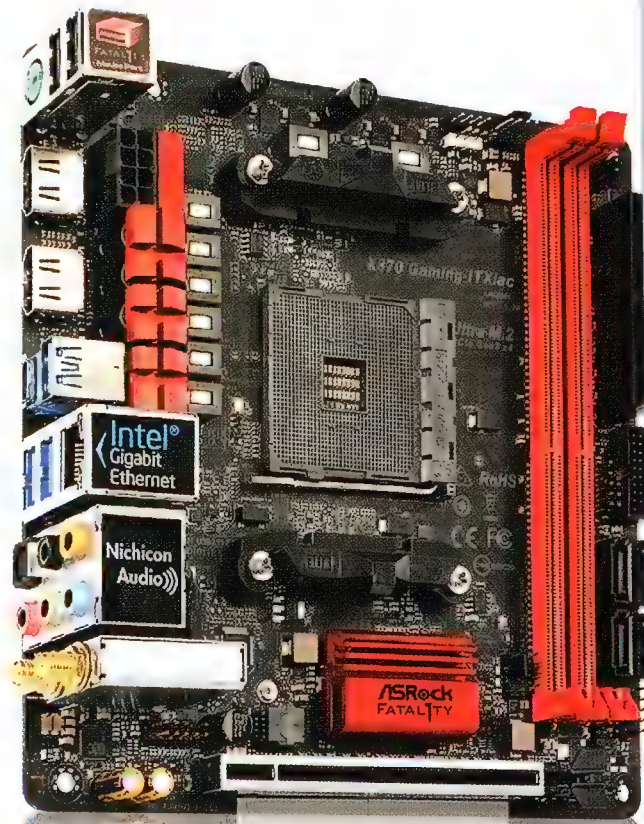
The project page hosts pre-built Deb packages for the Ubuntu family, and also universal .run installers that will work with any Linux distro.

Alexander Tolstoy



Mini Intel & AMD motherboards compared

Bennett Ring reckons small doesn't have to mean meagre, as these eight mini-ITX and micro-ATX motherboards can attest.



The days of the bulky PC tower are well and truly numbered. As our PC components continue to shrink in size and use less power, it's possible to pack the power of a mid- or full-sized PC into a package not much larger than a shoe box. It's the same with all forms of technology, where miniaturisation makes for much less obtrusive pieces of technology. Obviously, though, it comes at a cost; shrinking many components requires extra engineering, though already most components these days are small enough to fit into these tiny towers of power.

The most obvious cost is a loss of functionality – the backbone of your PC – and when you shrink this dramatically, there simply isn't room for extra outputs and goodies. There are two main small form factors for motherboards. Micro-ATX, which measures a maximum of 24.4 x

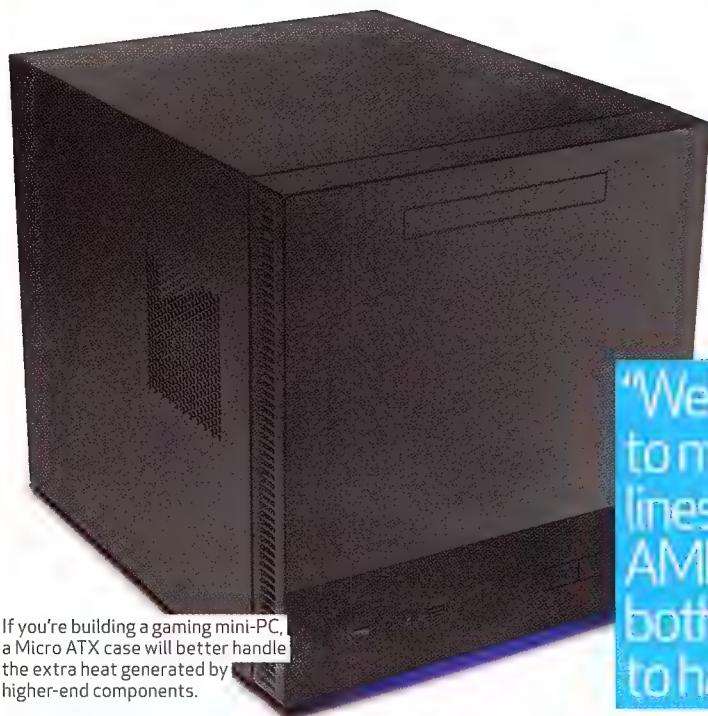
24.4cm, and mini-ITX, which is even smaller at 17 x 17cm. Boards of this size have been around for several decades, but they were limited to the most primitive of duties, such as powering electronic signs and retail point of sale terminals. Today's mini-PCs are different beasts, and there's a variety of configurations depending on your needs. One thing to really bear in mind is that, due to their smaller size, these mini-PCs

tend to be louder than a standard PC, as they need faster fans to push air through their confined spaces. On that note, though, let's look at the various types of configurations you can build into a mini-PC, as there are several different ways to make the most of their versatility.

How we tested

Our test components comprised of 16GB of Corsair DDR4-2666MHz (2 x 8GB) memory, a Samsung 950 Pro 256GB drive and a Corsair SFX PSU. In our Intel system, we used the top-of-the-line i7 8700K CPU, while our AMD system had the Ryzen 7 1800X, to eliminate any bottlenecks in the system. Finally, we used a Gigabyte Aorus GeForce GTX 1080 as the GPU. All drivers were up to date at the time of the testing.

MOBO SPEC TABLE						
BOARD NAME	MINI-ITX OR MICRO-ATX	CHIPSET	SATA 3 PORTS	M.2 PORTS	REAR USB PORTS	AUDIO CHIPSET
ASROCK Z370M-ITX/AC	MINI-ITX	INTEL Z370	6	1	2x USB 2.0, 6x USB 3.1 GEN1	REALTEK ALC892
ASROCK X370 GAMING-ITX/AC	MINI-ITX	AMD X370	4	1	2x USB 2.0, 3x USB 3.1 GEN1 (1x TYPE C)	REALTEK ALC892
ASUS ROG STRIX Z370-I GAMING	MINI-ITX	INTEL Z370	4	2	4x USB 3.1 GEN1 (1x TYPE C)	SLC1220
ASUS ROG STRIX X370-I GAMING	MINI-ITX	AMD X370	4	1	4x USB 3.1 GEN1	SLC1220
GIGABYTE Z370N WIFI	MINI-ITX	INTEL Z370	4	2	6x USB 3.1 GEN1, 1x USB 3.1 GEN1 TYPE C	REALTEK ALC1220
GIGABYTE AB350N GAMING WIFI	MINI-ITX	AMD B350	4	1	2x USB 3.1, 4x USB 2.0	REALTEK ALC1220
MSI Z370M MORTAR	MICRO-ATX	INTEL Z370	4	2	4x USB 3.1 GEN1, 2x USB 2.0	REALTEK ALC892
MSI B350M MORTAR	MICRO-ATX	AMD B350	4	1	4x USB 3.1 GEN1 (1x TYPE C), 2x USB 2.0	REALTEK ALC892



If you're building a gaming mini-PC, a Micro ATX case will better handle the extra heat generated by higher-end components.



Office users will find the integrated GPU in Intel's CPUs is more than fast enough for productivity tasks, as well as less demanding video tasks.

"We'd recommend going for a low-to mid-range processor, along the lines of an Intel Core i3-8100 or AMD Ryzen 3 1300X Processor, both of which have enough grunt to handle basic duties."

BUILDING THE RIGHT MINI-PC

WE DETAIL WHAT YOU NEED TO CONSIDER WHEN PUTTING TOGETHER THREE DIFFERENT MINI PC BUILDS.

BUILD #1:

OFFICE/PRODUCTIVITY MINI-PC

This type of small form factor (SFF) PC is by far the simplest. Tasked only with running email, web browsers and spreadsheets, they don't need a lot of power to get the job done. As a result, they can be so small that they'll even attach to the rear of your monitor if you go the mini-ITX route.

When it comes to the CPU, both AMD and Intel have excellent options. We'd recommend going for a low to mid-range processor, along the lines of an Intel Core i3-8100 or AMD Ryzen 3 1300X processor, both of which go for around \$150 and have enough grunt to handle basic duties. Both are quad-core, meaning they're adept at running multiple programs at once. When it comes to memory, 8GB is plenty, but you'll need to check what type your motherboard requires. Some will take standard DDR4 memory, while others require smaller SO-DIMM modules. If you do go for standard DDR4, ensure it doesn't have

a huge heatsink, as this may not fit within your small case.

As for graphics, this box isn't designed for gaming, so we'll leave a graphics card out of the Intel-powered box. Unfortunately, Ryzen doesn't have integrated graphics, so go for the cheapest graphics card you can find that'll fit in your box; something along the lines of an ASUS GeForce GT 1030 Low Profile Passive Cooled 2GB will set you back another \$100 or so, but the upcoming A-Series Athlon will solve that issue. Besides, with a discrete graphics card, this box will offer better gaming performance than the Intel solution. So it won't rock *Battlefield*, but *World of Warcraft* should be fine. Storage is best left to a budget SSD due to space concerns, though you may have room inside for an additional 3.5-inch mechanical drive. Finally, most SFF cases come with their own PSU, but you may need to buy a SFX/TFX/micro-ATX/mini-ITX power supply to squeeze it into the confines of the case.

BUILD #2:

COMPACT GAMING PC

It's now possible to build a SFF PC that has the same oomph as a full-sized tower. You'll need to go for a micro-ATX board to ensure you can fit in a graphics card which, in turn, means you'll need a slightly larger case. Even today's top-end cards will fit in these mini-boxes, though don't go for a behemoth with a triple slot cooler as it may not fit. Also check the height of the card to ensure it won't hit the side of your case. As for the CPU, sky's the limit. However, due to noise issues, we'd recommend aiming lower than the fastest of the fastest, such as an AMD Ryzen 5 1600X (\$300) or an Intel Core i5 8400 (\$250). Both CPUs hit 4GHz and have more than enough horsepower for today's games. 16GB of standard DDR4-2666MHz is a perfect amount, while a 256GB SSD and 1TB mechanical drive will take care of your storage needs.

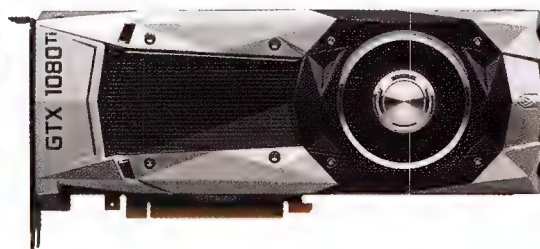
The biggest decision will be which GPU to go for. You can spend anywhere



The Fractal Design Array R2 is a great for office PCs as it includes sound proofing materials.



The Radeon RX 460 is perfect for HTPC boxes that require 4K playback, as it has hardware decoding for most 4k file types.



Even NVIDIA's GeForce GTX 1080 will fit inside most micro-ATX cases, and even some mini-ITX cases, perfect for mini gaming PCs.



This HTPC case is specifically designed for small theatre PCs, as it looks just like another piece of AV equipment and will fit in an entertainment unit.

“Ensure that your motherboard has the necessary outputs for your AV setup, be it HDMI, DisplayPort, SP/DIF or 3.5mm minijacks.”

between \$400 and \$900 on your GPU, and the more you spend, the better your performance will be. However, more powerful cards tend to get much warmer, leading to increased fan noise. Installing a couple of quiet case fans can help to reduce this issue. Finally, thanks to the slightly larger case, you could get away with a standard ATX power supply.

BUILD #3:
LOUNGE ROOM-FRIENDLY
MEDIA BOX

This PC is very similar to the office/productivity PC, as it doesn't require

that much horsepower. So we'd recommend the same specs as that machine, though would lean towards the Intel 8th-gen Core solution as it has integrated graphics. Just ensure that your motherboard has the necessary outputs for your AV setup, be it HDMI, DisplayPort, SP/DIF or 3.5mm minijacks. If you're running 4K videos, check your preferred playback software's CPU requirements, as they vary by program. You'll also want to make sure that it has at least HDMI 2.0 or DisplayPort 1.2 to get full 4K resolution at 60 frames per second.

As you can see, you don't need to compromise too much if you want a PC that can be tucked away out of sight. Obviously, power users running dual GPUs, massive water cooling systems and overclocked beasts will stick with today's mid-towers and towers, but for the rest of us, an SFF system is a very viable option that won't stick out like a sore thumb.

INTEL MINI-ITX & MICRO-ATX MOTHERBOARDS

	ASROCK Z370M-ITX/AC	ASUS ROG STRIX Z370-I GAMING	GIGABYTE Z370N WIFI	MSI Z370M MORTAR
PCMARK 8 - HOME (ACCELERATED)	5,132	5,367	5,312	5,278
HWBOT X265 BENCHMARK (1080P AVERAGE)	50.00	51.00	52.00	51.00
HWBOT X265 BENCHMARK (4K AVERAGE)	13.00	14.00	14.00	13.00
CINEBENCH R15 - OPENGL (FPS)	162.00	165.00	165.00	162.00
CINEBENCH R15 - CPU (MULTI-THREADED)	1,387	1,412	1,432	1,397
CINEBENCH R15 - CPU (SINGLE-CORE)	194	198	198	189
CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32TI)	2,789	2,851	2,859	2,780
CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32TI)	1,552	1,552	1,553	1,551
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)	21,821	21,854	21,851	21,844
FAR CRY PRIMAL (1080P AVERAGE FPS)	117	121	119	119

AMD MINI-ITX & MICRO-ATX MOTHERBOARDS

	ASROCK X370 GAMING-ITX/AC	ASUS ROG STRIX X370-I GAMING	GIGABYTE AB350N GAMING WIFI	MSI B350M MORTAR
PCMARK 8 - HOME (ACCELERATED)	5,039	5,056	4,989	5,035
HWBOT X265 BENCHMARK (1080P AVERAGE)	39.00	39.00	39.00	38.00
HWBOT X265 BENCHMARK (4K AVERAGE)	DNF	9.00	8.00	8.00
CINEBENCH R15 - OPENGL (FPS)	115.00	115.00	112.00	111.00
CINEBENCH R15 - CPU (MULTI-THREADED)	1,742	1,759	1,717	1,723
CINEBENCH R15 - CPU (SINGLE-CORE)	159	164	154	157
CRYSTALDISKMARK 5 - SEQUENTIAL READ (Q32TI)	420	424	423	437
CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (Q32TI)	396	394	385	381
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)	17,623	17,645	17,606	17,140
FAR CRY PRIMAL (1080P AVERAGE FPS)	93	95	91	91

INTEL MINI MOTHERBOARDS



Mini-ITX; Intel Z370 chipset;
6 x SATA 3 ports; 1 x M.2; 802.11ac Wi-Fi

\$199 | WWW.ASROCK.COM

ASRock Z370M-ITX/ac

Why pay more for less?

This mini-ITX board from ASRock departs from the company's usual policy of aiming for the more affordable end of the market, with a price tag of \$200 or so. That's rather pricey for mini-ITX board, let alone a micro-ATX board, so what makes ASRock think they can justify hitting our bank accounts a little harder than expected?

As a mini-ITX board, there isn't a whole lot of PCB space to include features, yet ASRock has managed to pack it with components. It's not often we see a mini-ITX board with a full six SATA 3 ports, but this is offset by the fact that there's only a single PCIe lane, in the form of a PCIe 3.0 x16 lane. There's just one M.2 PCIe 3.0 x4 slot; for this price, another on the rear would have been an expected inclusion. Twin memory slots are overclockable up to a top speed of 4000MHz, which is common for the Intel Z370 chipset within.

Offsetting this is the integrated 802.11ac Wi-Fi module which, unlike many other boards, doesn't need to be installed in your valuable M.2 slot. There's also dual Intel LAN Ethernet ports, offering network connectivity. Audio support is somewhat disappointing, relying on Realtek's ageing ALC892 codec, though it's got the usual upgraded capacitors and amps to help boost audio quality. While there are two HDMI ports, they're only capable of 4K at 24Hz, though the additional DisplayPort output can do 4K at 60Hz.

Other than the additional SATA ports, we're unsure why ASRock is charging a premium for this board when other competitors offer more for less.

Verdict

ASRock really needs to knock the price down to make this board worthy of your consideration.



Z370 chipset, 8 x USB ports (4 x USB 3.1 Gen 1),
4 x SATA 3; 1 x M.2; integrated 802.11ac Wi-Fi

\$309 | WWW.ASUS.COM/AU

ASUS RoG Strix Z370-I Gaming

Not cheap, and certainly not nasty.

As the second most expensive Intel-based motherboard in this roundup, we expected great things from this mini-ITX board. It's surprising to see such a high price on such a small board. For such a small size, ASUS has managed to squeeze everything but the kitchen sink onto this mini miracle.

It's running Intel's top Z370 chipset with twin memory modules that can run up to a speed of 4,333MHz with a total of 32GB of memory. Thanks to the small size, there's a single PCIe x16 slot, which is all gamers will need for their graphics card. Again, due to the tiny size, there are only four SATA 3 ports, along with a single M.2 PCIe 3.0 x4 slot.

Unfortunately the HDMI out appears to be 1.4, as it only supports 24Hz at 4K resolution, which is a big oversight at this price; at least the DisplayPort can run 4K at the full 60Hz.

802.11ac Wi-Fi is integrated alongside a single Ethernet port. An external antenna on a cord is included to improve reception.

ASUS has implemented its refined take on the common ALC1220 audio codec, known as the S1220A, which is a slight improvement over the audio solution found in other boards. A single SP/DIF output is included in case you don't want to use HDMI, along with five 3.5mm minijacks. A whopping eight USB ports also make the grade, four of which are USB 3.1 Gen 1, with another four available via mid-board connections.

It might be expensive, but for such a tiny board, it packs a punch. However, an HDMI 2.0 would have made this a perfect gaming box.

Verdict

A rather high price hike for a 'no-compromise on features or performance' focus.





Intel Z370 chipset; 2 x M.2 slots; 4 x SATA 3; HDMI 2 and DisplayPort output; SP/DIF; twin Ethernet, integrated 802.11ac

\$239 | WWW.GIGABYTE.COM.AU

Gigabyte Z370N WiFi

Incredible value for money for power users.

At just \$239, this Intel Z370 based board includes all of the features of the ASUS boards, and more, at a significantly cheaper price. Gigabyte has really pulled a rabbit out of the hat with this product, making it our pick of the bunch for mini-ITX boards.

Firstly, there's the fact that it comes with twin HDMI ports, one of which is 2.0, and a DisplayPort output allowing for full 4K at 60Hz regardless of which connection your display prefers. There's also two M.2 slots, with one cleverly mounted on the rear of the board, doubling up on your super-speed solid-state drives. Four SATA 3 ports are standard for a board of this size, but twin Ethernet certainly is not. There's even integrated 802.11ac Wi-Fi, a miracle at this price point.

A single PCIe x16 physical lane will fit even the fastest graphics card, while the dual memory slots can be overclocked up to 4400MHz. Audio is provided by the

industry default, Realtek's ALC1220 codec, along with the extra bells and whistles such as improved amps and capacitors. There's an SP/DIF out, and you can even do 7.1 over the 3.5mm jacks – there are five on the rear, with another two available with an HD front panel audio module. It's obviously Optane ready, being an Intel product, but with twin M.2 connectors we'd suggest filling these first.

Gigabyte has delivered an outstanding product in this board, with more features than most at an extremely pocket-friendly price. If you want to go for the smallest form factor without missing out on features, this is the board for you.

Verdict

Gigabyte has managed to deliver such a fully featured board at a stellar price.



Intel Z370 chipset; 2 x PCIe 3.0 x16 lanes (1 x16, 1 x4); 2 x PCIe 3.0 x1 lanes; two M.2 slots; Realtek ALC892 audio codec

\$199 | AU.MSI.COM

MSI Z370M Mortar

Lobbing a shot at the value end of the market.

Like the AMD version of the Mortar, MSI has once again gone for the micro-ATX form factor with this board, giving it the space required to allow more add-on cards in the extra PCIe lanes. Again, this comes at the expense of being slightly larger, but you'll still be able to fit this board in a case that is much smaller than your average PC.

The higher price is likely due to the use of Intel's top-of-the-line Z370 chipset, whereas the AMD version uses a mid-range chipset. There are four memory slots rated up to 4,000MHz, while PCIe lane options are plentiful. Twin PCIe x16 3.0 lanes are included, running at x16 and x4 speeds, again limiting dual GPU options to CrossFire only. There's also another two small PCIe 3.0 x1 lanes for your smaller cards, such as Wi-Fi or audio. Speaking of which, MSI has once again gone with the older ALC892 option, so a cheap sound card might not be a bad idea.

Surprisingly, there's no Type C USB connection on the rear I/O panel, instead limited to four USB 3.1 Gen 1 and two USB 2.0, all of which are Type A. Four SATA 3 ports is the norm, but the addition of an extra M.2 slot, making two in total, is a most welcome addition if you've got the moolah to fill them both up. A single Gigabit Ethernet connection is powered by Intel's I219-V chipset.

It's just a pity that the second x16 lane isn't x8 speed, as that would have allowed for SLI. Other than that, this board is hard to fault for the price point, though a newer audio codec would've been appreciated.

Verdict

If you're looking to build a micro-ATX Intel machine, this board offers darned good value.



AMD MINI MOTHERBOARDS

AMD X370 chipset; mini-ITX; 4 x SATA 3; 1 x M.2; Realtek ALC1220 audio codec

\$225 | WWW.ASROCK.COM

ASRock X370 Gaming-ITX/ac

Not quite the bang-for-buck we were hoping for.

Again we see ASRock taking on the high-end market. It's not as dear as some of the other boards, but it's also not quite the value proposition we've come to expect from ASRock.

This mini-ITX board has the usual features we've come to expect from these mini-backbones. There's just a single PCIe 3.0 x16 lane for your graphics card, along with twin memory slots. Thanks to AMD's X370 chipset, the memory is only rated to overclock to 3,466MHz, well below the 4,000MHz and above seen on Intel's Z370 chipset, not that it makes nary a difference for most real-world users.

Like all of the X370-based boards, this one will be eventually compatible with AMD's A-Series Athlon APU, and has the necessary video outputs to make the most of this chip's integrated GPU. Twin HDMI ports are included but, once again, limited below 60Hz, with a

maximum of 30Hz for 3840 x 2160 resolutions. This is a huge shame, as there's no DisplayPort that could deliver 60Hz, so gamers will want to avoid this board if they're looking for 4K gaming, despite the name.

At least there's integrated 802.11ac Wi-Fi, alongside four SATA 3 and one M.2 slot for storage, which is nothing to get too excited about. It has USB 3.1 Gen 1, with one Type C and three Type A on the rear. A single Gigabit Ethernet connection is one less than its Intel sibling.

Like the other ASRock board, we're not sure why the company is commanding such an expensive price when more compelling options are available on shelves.

Verdict

ASRock's miniature boards don't offer the same bang for buck as their competitors.



X370 AMD chipset; 4 x SATA 3 ports; 1 x M.2 port; integrated 802.11ac Wi-Fi

\$319 | WWW.ASUS.COM/AU

ASUS RoG Strix X370-I Gaming

The Ryzen equivalent.

It's fantastic to see so many AMD boards on the market since the release of Ryzen, and this has even extended into the SFF market. This board uses AMD's X370 chipset and AM4 socket. It'd be nice if Intel and AMD hadn't named their chipsets so similarly, as it's bound to be an issue for consumers when choosing between a Z370 or X370 board. It's compatible with both the existing Ryzen series of CPUs, as well as the upcoming A-Series Athlon APU, which includes integrated Radeon graphics.

This board uses the same tiny mini-ITX form factor, yet that hasn't stopped ASUS from loading up the PCB with plenty of goodies. It's got the same single PCIe x16 physical lane for your chunky graphics card, which is a must thanks to the board's lack of an HDMI output. There's a single PCIe 3.0 x4 M.2 slot, along with four SATA 3 ports. The outputs are not identical

though, with no HDMI or DisplayPort. This is a huge omission considering it is compatible with the A-series Athlon, which requires these to make the most of the iGPU inside this APU. There's also only three external 3.5mm stereo minijacks, though it does use the same S1220A audio codec. Six USB ports are on the rear I/O port, four of which are USB 3.1 Gen.

Considering the lack of video outputs and diminished audio outputs, this puts the AMD version of the ROG STRIX at a strict disadvantage if you're not using a discrete video card to turn it into a gaming beast. And if you're not, you're better off with one of the cheaper boards.

Verdict

Considering its inability to run without a discrete GPU, this board's price is hard to justify.





X370 chipset; 802.11ac M.2 module; 1 x M.2 slot, 4 x SATA 3 slots; 1 x HDMI 1.4 1 x DisplayPort outputs

\$150 | WWW.GIGABYTE.COM.AU

Gigabyte AB350N Gaming WiFi

Perfect for those looking for a budget build.

If you want a budget build, look no further. There's a catch, however. Until the release of the A-series Athlon APU, you'll be limited to using a Ryzen processor thanks to the AMD B350 chipset, which requires a discrete GPU, adding another \$100 or so to the cost. Thankfully, the A-Series is just around the corner.

For such a cheap price, you can't expect top of the market features nor performance. The B350 chipset is one of AMD's more affordable chipsets, and has a slight performance drop over the X370. It also doesn't overclock as well, with the DDR4 memory topping out at 3,200MHz, though this doesn't make a lot of difference in the real world. Unlike Intel, though, it can use ECC memory where data integrity is of the utmost importance.

We're happy to report that this board includes both HDMI and DisplayPort outputs, though you'll be

limited to 4K at 24Hz if you use the former. Realtek's ALC1220 audio codec has been wheeled out once again for audio duties, and supports 7.1 via 3.5mm minijack, or surround via SP/DIF. A single LAN port is included, and to our amazement, there's even an 802.11ac Wi-Fi module that you can use to fill the single M.2 slot. A single PCIe 3.0 x16 physical lane is also included. Four SATA 3 ports is standard in this mini-ITX board, though USB 3.0 ports are lacking, with just two alongside the four USB 2.0 ports.

Still, at this price point, this will be a fantastic budget platform when the A-series APUs are released, provided they're not too expensive.

Verdict

Aimed at the budget end of the market, its lack of features is sweetened by the price.



AMD B350 chipset; 2 x PCIe x16 lanes (1 x16, 1 x4); 2 x PCIe 2.0 x1 slots; Realtek ALC892 audio codec

\$125 | AU.MSI.COM

MSI B350M Mortar

A larger PCB equals more options for your build.

It doesn't get much cheaper than this micro-ATX, but the extra size offered by its form factor means it actually offers more options for a versatile configuration than boards twice the price. At 24.4 x 24.4cm, it's considerably larger than the 17 x 17cm of mini-ITX boards, and thus, has many more expansion slots. The pay-off is you'll obviously need a slightly larger case, though.

These expansion options focus mainly on the PCIe slots. There are two PCIe x16 physical lanes, though only one is 3.0 x16 speed, while the other is 2.0 x4. This means Nvidia SLI isn't an option, as it requires x8 on both slots, but you can run twin AMD cards in CrossFire mode. There's also two PCIe 3.0 x1 slots as well. Based on the B350 chipset, this motherboard supports both Ryzen and the upcoming A-Series APU, and includes DVI-D, HDMI 1.4 and DisplayPort outputs. We wish it was HDMI 2.0,

though, as that's the most common connection on today's 4K TVs, so if you're connecting via HDMI at 4K, you're limited to 24Hz.

The usual four SATA 3 ports and single M.2 port are included for storage, and there's room for four memory slots, allowing a maximum of 64GB on the dual memory slot boards. It's only rated to overclock up to 3,200MHz, though – a far cry from the 4,000MHz and above on other boards.

There are six USB 2.0 and four USB 3.1 Gen 1 ports on the rear panel (1 x Type C), a welcome inclusion at this price. If there's one flaw, it's the older Realtek ALC892 audio codec, which is inferior to the ALC1220 used on most of today's boards. ■

Verdict

The slightly larger form factor has allowed MSI to include many more PCIe lanes than the smaller boards.





The home of technology

techradar.com

Size does matter

Need a small case to go with your mini motherboard? Bennett Ring tests six to sort the good from the great.



Sick of having a PC the size of a small bar fridge? Fear not, as mini-ITX and micro-ATX PC cases are now becoming more popular than ever. Between half and a quarter of the size of a mid-tower, they're designed to minimise their footprint and tuck snugly away out of sight. Unlike mini-ITX and micro-ATX motherboards, there's no real specifications about the exact size of these cases. Therefore, you're going to need to check the specs about each case to see if it will fit your chosen motherboard.

It's only thanks to the miniaturisation of other PC components that these mini-PCs are becoming more popular. However, this means you may need to buy smaller components than would fit inside a standard PC, such as an M.2 SSD rather than a SATA 3 SSD, which can lead to higher overall costs than a standard sized PC.

The beauty, though, is that many of these cases can sit next to the TV without being obtrusive, and some cases will even fit inside a standard AV stand below your TV, alongside your console or Blu-ray player if you have one. These tend to be known as HTPC (home theatre PC) cases, though, which we haven't included in this roundup. Instead, we've looked at eight of the mini-tower style cases, and there are dozens to choose from.

WHAT TO LOOK FOR IN A SMALL FORM FACTOR CASE

When buying a small case, the most important decision is whether it has the space for what you want to put inside. Obviously, if you go for a smaller mini-ITX board without a graphics card, you can get a tiny case. On the other hand, if you want to pack a GeForce GTX 1080 with a micro-ATX motherboard, you're going to need something bigger.

What we found was that the interior design of most cases tend to follow very similar layouts. They'll probably have the PSU mounted in the bottom, and many of these cases come with a PSU included. If they don't, you'll need to check whether the case can fit an ATX PSU, or requires a special, smaller SFX PSU, which usually max out around the 500-600W range. That's still ample for most users, though.



You may need an SFX PSU like this Corsair-SF600 to fit inside extremely small cases.

Build quality is another important factor. Something built from a more solid steel construction will obviously handle accidental bumps better than a plastic fantastic el cheapo. Arguably the second most important consideration though is aesthetics; do you like the way the case looks, and will it 'fit' with your home's interior design? This is ultimately a personal decision, with some loving a case festooned with glowing Neon and a side window to show off the disco lights inside, while others prefer subtle, sleek lines that blend into the background. We tend to find that it's the younger audience attracted to the former, while older users prefer the more minimalist look, but at the end of the day... it's a matter of taste.

Please note that we extended the invitation to this round-up to a wide range of companies including the likes of Corsair and Shuttle, but they declined to take part. Fractal ended up providing half of the six cases we reviewed, as the company has really focused on the mini-PC case market in recent years.

TABLE HEADLINE

CASE NAME	SIZE (CM)	MINI-ITX COMPATIBLE	MICRO-ATX COMPATIBLE	WEIGHT	DRIVE BAYS	FRONT USB PORTS
COOLER MASTER ELITE 110	26 x 20.8 x 28	YES	NO	2.65KG	3 x 3.5-INCH	2 x USB 3.0
COOLER MASTER MASTERBOX LITE 3	40.6 x 18 x 37.9	YES	YES	3.65KG	1 x 5.25-INCH, 1 x 3.5-INCH, 1 x 2.5-INCH	2 x USB 3.0
FRACTAL DEFINE MINI C TG	39.9 x 21.2 x 39.9	YES	YES	6.8KG	2 x 3.5-INCH, 3 x 2.5-INCH	2 x USB 3.0
FRACTAL MESHIFY C MINI - DARK TG	39.5 x 21.2 x 39.9	YES	YES	6.28KG	2 x 3.5-INCH, 3 x 2.5-INCH	2 x USB 3.0
FRACTAL NODE 804	34.4 x 30.7 x 38.9	YES	YES	6KG	8 x 3.5-INCH, 2 x 2.5-INCH	2 x USB 3.0
THERMALTAKE VERSA H18	39 x 20.5 x 38	YES	YES	4.5KG	2 x 3.5-INCH, 2 x 2.5-INCH	1 x USB 3.0, 2 x USB 2.0



Steel Alloy Mesh construction;
mini-ITX only

\$49 | WWW.COOLERMASTER.COM

Cooler Master Elite 110

Great airflow comes at the cost of noise pollution.

At a mere 50 bucks, this is one of the most affordable cases on the market. That's probably because there isn't a whole lot of material used in its construction. Rather than having solid side and top panels, it uses mesh instead, which allows for a huge leap in airflow. Conversely, it also allows all of those various fan noises bounce right out without any hindrance, so it's not so great if you want a silent PC that's packing several noisy fans. It comes with a single 120mm fan at the front, but has space for two more 80mm fans at the rear, or even a 120mm radiator at the front.

This cubic case can only squeeze a mini-ITX motherboard inside, so forget about micro-ATX. Due to the small size, you'll have to go for a smaller graphics card, as it's limited to a maximum graphics card length of just 21cm, not big enough for the highest end cards. Your CPU cooler must

also be no taller than 7.6cm, which isn't too much of an issue. All of the external ports are on the left side, including twin USB 3.0 Type A, and audio in and out via 3.5mm minijacks. Despite the small size, it can fit an ATX PSU inside, which makes shopping around for a power supply that much easier. There's room for three 3.5-inch drives, or two 3.5-inch drives and three SSDs, or four SSDs if you'd like to stick with an all solid-state storage system.

This is a very simple case, reflected by the price and lack of configurability. But if you're looking for a cheap media box that will only be running a low-speed CPU with quiet fan, it could be just what your inner couch potato ordered.

Verdict

There's nothing fancy about this case, but it's a nice price basis for a simple media or productivity box.



2 x 3.5mm audio input/output;
left Perspex side; mini-ITX and micro-ATX

\$55 | WWW.COOLERMASTER.COM

Cooler Master MasterBox Lite 3

A mini-mid-tower.

The second case from Cooler Master is much larger than the first, adopting the traditional rectangular style of a standard tower, yet only half the size, measuring 40.6 x 18 x 37.9cm. There's room inside for either a mini-ITX or micro-ATX motherboard, expanding the possibilities when customising your build.

To our surprise, this case comes with an optical drive cage on the front, whereas most of today's cases have done away with these. You don't have to use it, though, as it can be configured to handle one mechanical or two solid-state drives. If you do use this for Blu-ray drive, though, the range of storage options are quite limited, to just a single 3.5-inch and single 2.5-inch drive; that's less than the Elite 110, which is much smaller.

Four expansion slots adorn the rear, perfect for a micro-ATX board, while a single 120mm fan comes pre-installed at the front

of the case. You can yank this out and replace it with a 240mm radiator if you prefer. A full-sized ATX PSU squeezes into the top rear of the case, and there's plenty of space for a full sized graphics card up to 34.5cm in length. The left side of the case is a Perspex window, allowing you to show off your hard-earned hardware.

At a mere \$55, this is one of the cheaper micro-ATX cases on the market, which is probably why there aren't that many features to speak of. Still, it's decent value for the price.

Verdict

Aimed at the budget end of the market, the surprising lack of storage options is its only downfall.





✓✓✓
apc
RECOMMENDS

Tempered glass side panel and sound-dampening; mini-ITX and micro-ATX

\$149 | WWW.FRACTAL-DESIGN.COM

Fractal Define Mini C TG

Customisation is key in this mini-PC tower.

As one of the most expensive mini-PC cases on the market, we expected big things from the Mini C TG. Yet Fractal doesn't have so many small cases for no reason; they were one of the first manufacturers to get in on the trend of ditching big towers for tiny boxes.

It's smaller than most mini-towers, measuring 39.9 x 21.2 x 39.9cm, and uses tempered glass on the left hand side while the majority of the rest of the case is steel. The front has a brushed metallic look that will nicely sit alongside your designer furniture, and it's also packed with sound dampening material on the metal sides, keeping those annoying buzzing fans away from sensitive ears.

Like most Fractal cases, it's highly modular, allowing you to move various components around for your ideal configuration. The five drive bays can be swapped individually and each can hold up to a 3.5-inch drive or

2.5-inch SSD. There's also a PSU shroud, with room for a full-sized ATX PSU, which hides away the myriad messy cables extending from your power box. Four expansion slots on the rear are perfect for this micro-ATX and mini-ITX compatible case, while nylon filters on the front and base can be quickly removed to make cleaning simple.

You're limited to a 240mm radiator at the top or front, and room for five fans. Your graphics card can be up to 31.5cm in length, while there's 17.2cm of space for your heatsink. For the price, we would have liked more than just two USB ports and twin 3.5mm mini-jacks on the exterior. This is a quality piece of kit, but the price is a little high.

Verdict

Silent, modular and with a nice subtle design, only the price stops this case from getting top marks.



✓✓✓
apc
RECOMMENDS

Tempered glass side and front mesh panel; micro-ATX and mini-ITX

\$149 | WWW.FRACTAL-DESIGN.COM

Fractal Meshify C Mini - Dark TG

The unique facia is matched by a unique interior.

Just look at the front of this case – it's as if the designers were inspired by Melbourne's Federation Square thanks to the angular design. It's definitely original, and rather futuristic looking. It's actually a mesh design as well, allowing plenty of air to be sucked into the front via the twin 120mm fans that come with the case.

A total of seven fans can be installed, or a 280mm radiator at the front, a 240mm radiator at the top, or a 120mm radiator at the rear. In other words, you're spoiled for choice when it comes to cooling.

The left side of the case is made from tempered glass, while the right side is metal, with the dark tempered glass only showing off glowing neon within. Not that you'll notice the full-sized ATX PSU, as this is covered in a PSU shroud to hide this hideous-looking component. Thanks to the larger dimensions of this

case (39.5 x 21.2 x 39.9cm, making it micro-ATX capable), there's room for a sizeable graphics card up to 31.5cm in length, while your CPU cooler can stretch its wings to a generous 17.2cm in height.

For a small tower, it's surprisingly heavy at 6.28kg, thanks to the tempered glass, so it may not be the best choice for LAN gamers. There's space for up to five drives, and a 3.5cm gap between the motherboard and side panel leaves plenty of room for hiding cables.

It's not exactly cheap, but we love the design and tempered glass, not to mention the space inside. If you're looking to spend a little more on your mini-PC, this is a tempting option.

Verdict

If you're looking for something that looks out of the ordinary, look no further.





Plastic side panel; mini-ITX and micro-ATX

\$155 | WWW.FRAC TAL-DESIGN.COM

Fractal Node 804

This tiny case offers a big feature list.

If you want Fractal quality but in the smallest possible form factor, this is the case for you. It can handle both micro-ATX and mini-ITX. Yet it still manages to act like a mini TARDIS, squeezing lots of features into a tiny amount of space.

For starters, there's a whopping 10 fan mounts, which is simply crazy for such a small box, and three 120mm fans are included at purchase. A fan controller is included, so you don't need to patch them all into your motherboard.

There's also eight 3.5-inch drive bays, alongside twin 2.5-inch SSD bays, allowing for a huge amount of storage. Five expansion slots adorn the rear, though you'll be lucky to find a micro-ATX board with that many PCIe lanes. Despite being smaller than other Fractal cases, it can fit a larger graphics card, at 32cm in length. Meanwhile CPU clearance is a little shorter, at just 16cm, so take care when choosing your air

cooler. Radiator fans can jam a 280mm radiator at the top, or stick to the regular 120/240mm at the front.

There's space enough also for a full-sized ATX power supply, while the left side uses a plastic window to show off the hardware within. Fractal's trademark brushed aluminium face panel is present, and we love the look of this modern minimalist style.

Being Fractal, you can expect to pay a premium for this box, but considering just how much you can pack into the tiny space, the slight increase in price over competing boxes is worth it for those who want the highest quality.

Verdict

Packing an impressive amount of hardware into such a tiny box is no easy feat, but Fractal has done it.



Mesh front and plastic side panel; mini-ITX and micro-ATX

\$49 | WWW.THERMALTAKE.COM

Thermaltake Versa H18

This tiny box comes with a tiny price.

Aimed at builders, this delivers a very simple, basic case for entry-level buyers at a mere 50 bucks. Yet Thermaltake hasn't had to cut too many corners to deliver this case at such a price, with a surprising amount of functionality.

Shaped like a regular tower but at half the size, measuring 39 x 20.5 x 38cm, it's compatible with both micro-ATX and mini-ITX motherboards. Four expansion slots allow you to make the most of the latter, but the amount of storage options is quite limited. There are just four drive bays, two for 3.5-inch drives and another two for 2.5-inch SSDs.

There's room for eight fans in total, but only one is included at the rear, in the form of a 120mm 1,000rpm fan. However, you can fit a full 280mm radiator in the front, or a 120mm version at the rear, with no option for top mounting. You get 35cm of graphics card space;

more than enough for today's most powerful cards, though the 15.5cm clearance for the CPU cooler isn't exactly massive.

As for aesthetics, personally, we don't think it's the most attractive case on the block, with a very simple steel design and transparent window on the left-hand side. The front is a mesh finish, allowing for excellent air-flow, but also allowing sound to easily escape. There's no option for an optical drive – like most cases these days – and the inclusion of a USB 3.0 port alongside twin USB 2.0 ports on the front is a welcome inclusion.

It might not be as versatile as other cases, but the Versa H18 does offer excellent value for money.

Verdict

If you're looking for a rock-bottom price with a decent feature set, this case offers great bang for buck.



When the bark is louder than the bite

Dealing with mini-PC noise pollution.

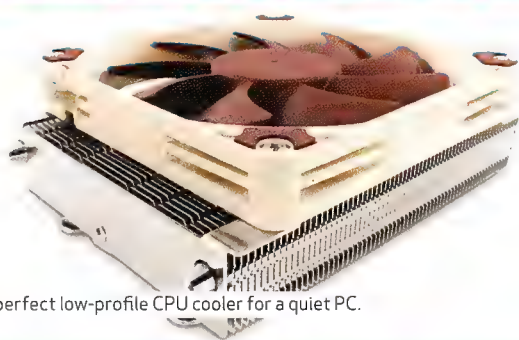
If you're building a miniature PC, there's a good chance that it's going to be living in your family room or home theatre. As such, you expect it to be a well-behaved little box, just like your Blu-ray player, gaming console or set-top box. Unfortunately, there's one issue with mini-PCs that can be annoying if not addressed — fan noise.

Due to their smaller dimensions, the amount of cooling air within the case is much more limited than a standard PC.

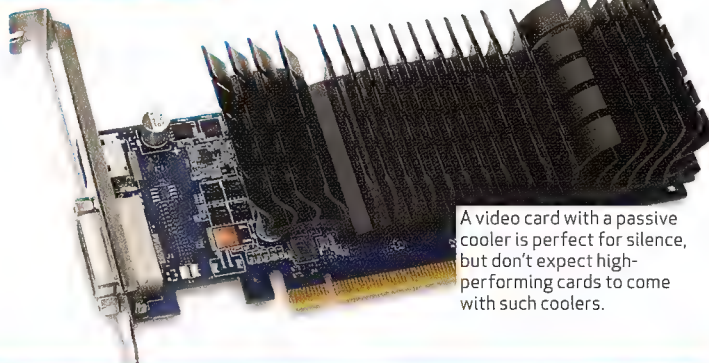
This means there's less air around for your motherboard, video card and CPU's heatsink to disperse heat into, which can lead these components to running hotter than usual. As a result, the fans on these coolers have to spin up to higher speeds, which can lead to the annoying buzz factor, where the humming of several fans makes your PC sound like a hairdryer. Not exactly wanted when watching a movie during a silent, suspenseful scene.

This is why we don't suggest a mini-PC if you're looking at overclocking, as this increases running temperatures right off the bat. It's also why we recommend buying components that are designed to keep noise levels down. In cases, this is usually in the form of sound-insulation on the panels, as well as low-noise fans. As for components, you can find CPU heatsinks that are specially designed to be quiet while remaining small enough for mini-PCs, and video cards that have quieter coolers than the rest. Sure, these components may cost a little more, but the saying "Silence is golden" exists for a reason...

"Due to their smaller dimensions, the amount of cooling air within the case is much more limited than a standard PC."



The perfect low-profile CPU cooler for a quiet PC.



A video card with a passive cooler is perfect for silence, but don't expect high-performing cards to come with such coolers.

What about a barebones PCs?

If you'd like the smallest possible PC that can still handle a discrete GPU, you might like to look into barebones small form factor PCs.

Shuttle is probably the most well-known brand that makes these PCs, and they're rather different to your average PC. For starters, they generally use custom-sized motherboards that aren't micro-ATX or mini-ITX, often being even smaller than mini-ITX. Secondly, they also usually come with their own specialised power supply that is even smaller than the SFX PSU form factor. The result is that many can only pump out around 450W of power, but that's still enough for today's power sipping components, even if you're building a gaming box.

What they don't come with is memory, a CPU, discrete graphics card or storage, which you'll have to buy after purchase. As they come with specialised motherboards and PSUs,



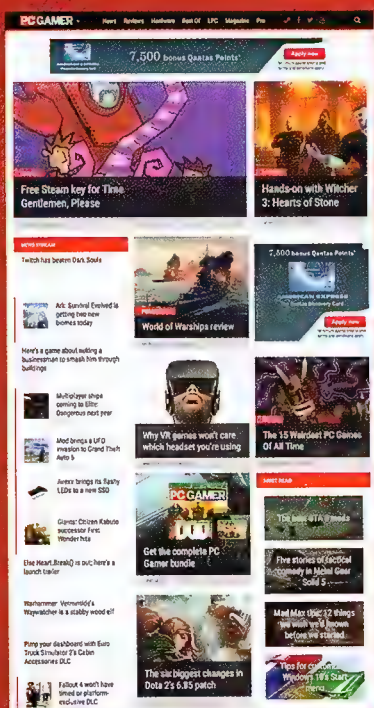
This Shuttle barebones PC shows that the motherboard and PSU are usually included — but you'll need to bring the other components to the party.

they're more expensive than building your own mini-PC, with prices starting from \$350 all the way up to \$700. They can also be a little noisy; since they're so small, they need to push air harder through a more confined space, which leads to fan noise.

If you want to go ultra small, then an Intel NUC (Next Unit of Computing) might

be for you. Around the size of an Apple TV box, these tiny barebones PCs usually require SO-DIMM memory and storage, but are perfect if all you want is a media or office productivity box. Just be warned, they're not exactly cheap. ■

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COMPLETE GUIDE

THE PC BUILDER'S BIBLE

**APC's TOP TIPS AND TRICKS TO MAKE EVERY
BUILD AS EASY AS CAN BE: DODGE COMMON
PITFALLS, FIX TROUBLESOME BOOT
CONUNDRUMS, AND ENJOY EVERY MINUTE
OF YOUR DIY SYSTEM-BUILDING EXPERIENCE**

System building is one of the central tenets of the PC enthusiast community. It's something we should all aspire to. Here at APC, we've built rigs and taught others how to craft their own, both in person and across these pages, countless times. And with one very good reason: You get a real sense of pride from constructing your own machine, and an even greater one from teaching others how to do it. And with the added benefits of knowing every part that goes into your build, saving some cash, and understanding how to troubleshoot your system if it goes wrong, it's hard to ignore the advantages that system building brings.

A lot revolves around system building across the industry. From hardware development, to the custom modding scene, to the liquid-cooling community, the gamers, the video editors, overclockers, Linux users,

web developers, you name it — all of them are based around that one basic principle. And for many, it's what brought them to this community to begin with.

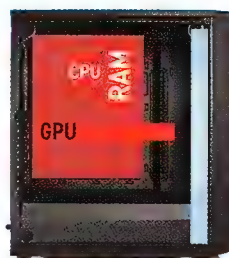
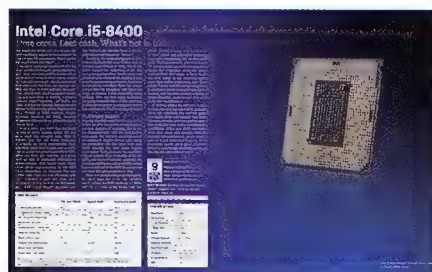
Yet, in today's age of easy-to-construct behemoths, is there really that much hidden knowledge to be discovered when it comes to these builds? Well, from the budding builder to the artisan crafter, a little knowledge can go a long way, and even today, some of us beaten-up techies here at APC still learn a thing or two whenever we step foot into each issue's PC Builder Masterclass. So let us impart our knowledge to you. We've broken more cases, sheared off more flesh, and destroyed more hardware than you can possibly imagine. Allow us to divulge those secrets and give you our very best tips and tricks for building your own slice of dream-machine pie.

Zak Storey



The perfect plan

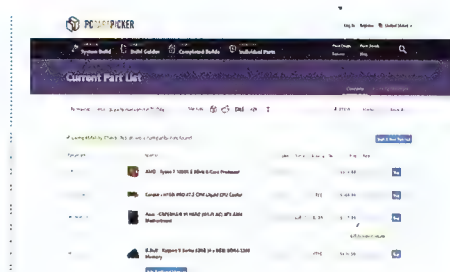
Research, plan, budget. Those are the first things you need to do when your mind wanders toward building a new rig.



Front:
3x 120mm

Rear:
1x 120mm

Roof:
2x 140mm



TIP 1

A little knowledge can go a long way when it comes to building your perfect PC. And the best place to start is reviews. You can look at all the build guides in the world, but if you don't know what gear is right for you, you're going to end up sorely out of pocket and with a system not fit for purpose. Reviews are a huge source of information. Whether they're online, on YouTube, or in good old APC, you can learn how something works, how to install it, and how it performs when push comes to shove. Second to reviews are manufacturers' websites. Reading PDFs and install manuals ahead of time will make the build process far easier and help you set everything up after, too.

TIP 2

Next up is the planning phase. This is more of an environmental and aesthetic decision-making process than anything else. Figure out how much space you have for your new rig, where it's going to be situated, what form factor you want, and what chassis is right for you — remember, airflow and ambient temperatures are key. Then you've got to think about what hardware will fit where. Do you want a 240mm AIO up front? Will it conflict with your GPU? What will internal temperatures be like? Can you install it on the roof? Or perhaps an air cooler is better? All of these things can be answered long before you even take the first step into an online purchase.

TIP 3

Taking the plunge and choosing what hardware is right for you relies heavily on the first two tips. Look at what cash you have and allocate it accordingly. Make sure you buy hardware that's either appropriate for what you do today, or what you will do tomorrow. Don't allocate half your budget to cooling and aesthetics if you can get 30% more performance out of it elsewhere. And make sure you don't waste cash (on faster memory kits for Intel, for instance) where you don't need to. If a sale is coming up, wait for it — they're usually worth it. Hell, you can drip-feed hardware, too; buy one or two things per month instead of going all-out in one go.

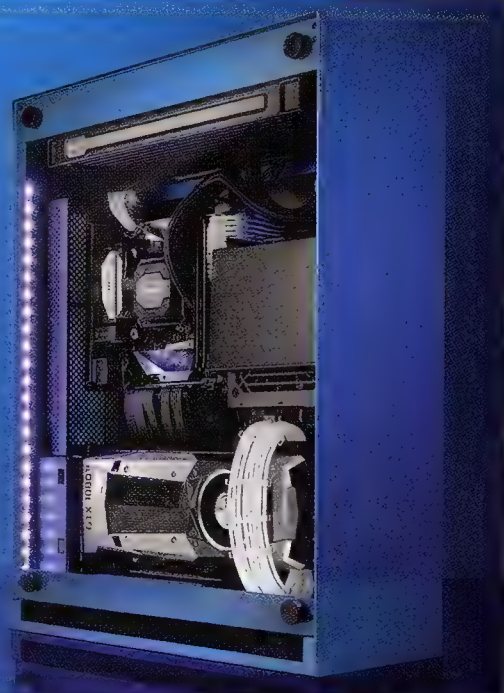
DIY vs. pre-built

We're in an odd place with pricing, and that old adage, "It's always cheaper to build your own rig," doesn't hold true right now — at least, not until Samsung and co get their extra memory plants up and running. The memory shortage and cryptocurrency mining have ruined it for everyone. So how can system integrators still offer us cheap pre-built machines? It's down to pre-emptive bulk buying. Most companies that offer pre-built systems buy all the hardware they need in bulk, well ahead of time. So for the time being at least, they're still running off older prices and can drastically undercut the current market.

Usually, the longer a memory standard has had to mature, the cheaper it becomes to produce, so

the market stays ahead of the system integrators. But given current circumstances, that's just not possible.

That's not to say that system integrators don't provide decent systems. Some of the best machines we've seen come from the likes of Falcon Northwest, Digital Storm and others. After all, when your livelihood revolves around building unique, bespoke, and powerful machines, you're going to learn a thing or two about putting together a stunning rig. Couple that with extensive parts and labour warranties, and they immediately become very attractive propositions, especially if you don't have the time or inclination to build your own.



Tools of the trade

Nowadays, all you need to build most systems is a good old trusty Phillips head screwdriver, but here's a selection of the other frequently used tools and handy gadgets we turn to in our PC-building escapades.

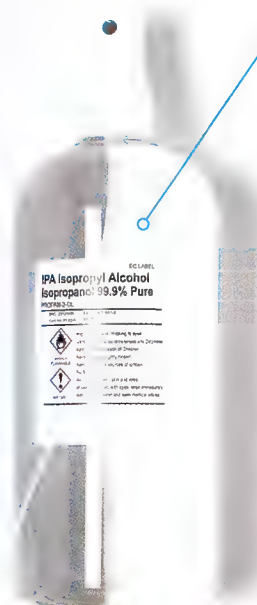
Magnetic bowl

You can pick up this handy Park Tool magnetic bowl for about \$10 from Amazon. Amazingly useful for storing all your bolts and screws, you can attach it to anything metallic, at any angle, without the worry of losing any of the stuff inside. Plus, rub your screwdriver up against the bowl, and voila — magnetic screwdriver. That's science, folks.



Isopropyl alcohol

This is one of the few liquids that won't kill your hardware if it gets on it—it's fantastic for cleaning off cruddy thermal paste and is a good cleaning agent to get rid of smudges on almost anything. Just don't rub it on soft plastic stickers and the like. Or inhale it. Or get it on your skin. Or try to drink it. Seriously. Just be careful.



Thermal paste

We stick to just one brand: Noctua's NT-H1 Thermal Compound. It's a non-conductive thermal paste with a satisfying consistency. You won't see revolutionary changes in temperature with a higher quality paste, but you'll see some. Just make sure you don't use conductive paste.



Cable ties

Amazon will happily sell you 300 of these for about \$10, and they are, by far, the most useful PC building accessory you can own. Whether it's tying up spare cables, strapping cables to your frame, or jerry-rigging all sorts of mounting procedures for less-than-amiable products, the humble cable tie is clean, easy to use, and one of the most versatile tools on the planet.



Screwdriver & socket set

A decent set of screwdrivers will make builds far easier. Get a good kit with a variety of different sizes. Whether it's torque screws, tiny M.2 screws, stand-offs, Allen screws, or even proprietary hex screws on the back of GPUs (here's looking at you Nvidia), a good set will cost you about \$40, but potentially last a lifetime.

Chassis stripdown

So, you've bought all the hardware, your tools are prepped — what's the next step to ensure your build is as easy as it possibly can be?

TIP 1

Case stripdown

The first thing to do (other than lay out all your hardware, and take a shot for Instagram, obviously), is strip your case down to its frame. Carefully unscrew, pop off, and remove every panel you can find. You can also remove the dust filters, and any hard drive cages you don't need. Doing this improves airflow, makes your build infinitely easier to manage in the early stages, and stops you manhandling and potentially damaging some of the more aesthetically pleasing panels (damn you, brushed aluminium).

TIP 2

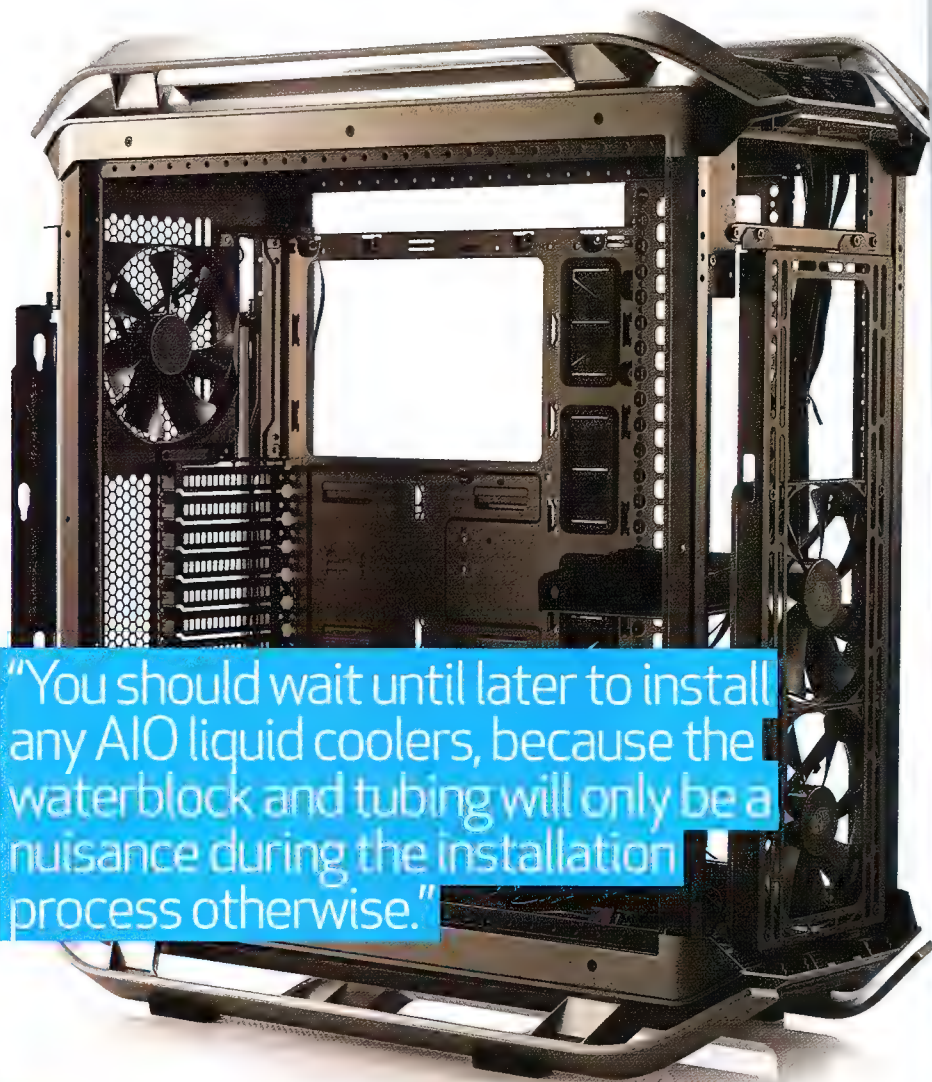
Panel storage

It's smart to keep your part boxes, at least for a year or so, until the warranties run out. That said, there's an immediate use you can make of the box your chassis came in. The larger side panels and glass windows can slot carefully into your cardboard case box, between the polystyrene packing material, to ensure they don't get damaged or lost. You'll know where they are, and you can rest assured they're not going to fall over or get scratched during the build process.

TIP 3

Meditate

Not really, but you should visualise where your hardware is going to go. This is a great time to do a test fit — place your hardware where you think it'll go and check there won't be any problems or conflicting parts. Imagine your cable routes, check there's enough room for your fans; it'll save time in the long run.



"You should wait until later to install any AIO liquid coolers, because the waterblock and tubing will only be a nuisance during the installation process otherwise."

TIP 4

Replace the stock fans

Most stock fans are more than adequate for providing some sort of cooling, but if you have an eye for detail, you prefer more performance-oriented fans, or you're just after something that's a little quieter, replacing those stock polypropylene blades now is definitely the best decision. With unfettered access to every area at this point, it's easy to route the cables behind your case, and install them without worrying about the chassis being too heavy when everything's inside. One thing we would say is that you should wait until later to install any AIO liquid coolers, because the waterblock and tubing will only be a nuisance during the installation process otherwise. Also, if the top of the chassis is pretty tight, it might be worth holding off on those, at least until you've had the opportunity to plug in the motherboard power cables, and any other fan cables you're going to need.

TIP 5

Pre-thread your cables

When working with more budget-oriented cases with little cable management room, pre-installing and threading your cables ahead of time is a smart way of making a cleaner, tidier build without necessarily breaking the bank. One particularly problematic cable tends to be the eight-pin EPS, or CPU power. For cases without any cable routing room, you can actually lay the CPU cable under the motherboard itself and into the top left-hand corner of the case. Then, after you install and secure your motherboard down (not forgetting the I/O plate, of course), you can plug in and install your CPU cable, keeping it out of the way and tidy in the process. In pricier options, and with modular power supplies, now is the perfect time to decide what cables you're going to need and pre-install the lot, tying them to the back of the chassis where you can, using the cable ties we mentioned earlier.



Cooling mastery

Making sure your rig can handle the thermals thrown around inside is imperative, so how can you alleviate these conundrums ahead of time?

TIP 1

Right fan for the right job

If you're looking at maximising your cooling efficiency, selecting the right fan for the right job is critical. There are two types of fan design: static pressure fans (with fat, thick blades) designed for high-pressure environments where they need to push air through radiators or heatsink fins efficiently; and airflow fans (with multiple skinny blades) which are designed to move as much air through a system as quickly as possible, but without the same amount of force as their static pressure cousins. At the very high end, you'll find some static pressure fans that can shift as much air as an airflow fan, but that comes at a cost. Noise is also a factor. The bigger the fan, the slower the RPM usually, and the less noise. Typically speaking, if you're after a quiet rig, look for fans that operate below the 1,200rpm mark. You can control faster fans through the BIOS or a fan controller to go slower than the advertised speed, but you may encounter coil whine because of it.

TIP 2

Cooling with style

So how do you cool your processor? Well, it's down to personal preference and your CPU. With most mainstream locked Intel processors, you can get away with the stock heatsink. If you prefer things more chilled, grab an aftermarket air tower. But there's nothing to say you can't use a 240mm AIO on a Core i3 or Ryzen 3. Any Intel K series processor at an i5 level,

or Ryzen 5 or higher, should be cooled by a substantial tower solution or a minimum of 120mm liquid cooler (\$90 or more). If you intend to overclock, this is a must. For Core i7 or Ryzen 7 and higher, with overclocking, use a 240mm AIO or \$90+ air tower. If you've not got much space, or limited intake, we recommend an air cooler over the all-in-one.

TIP 3

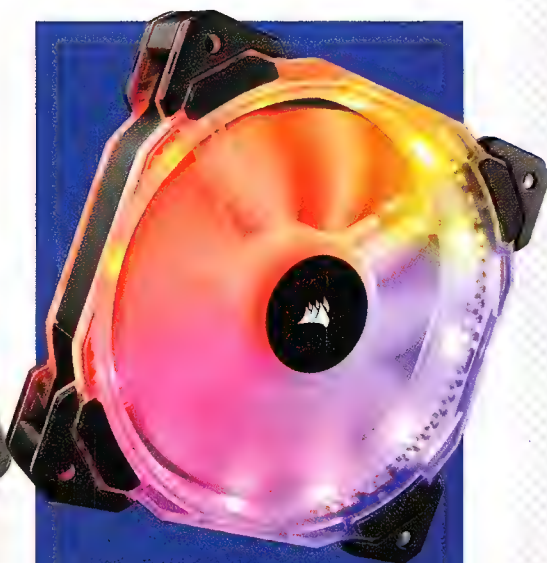
Air pressure

You've got the right fans and CPU cooling; next up is internal case air pressure. There are two trains of thought: balanced and positive. Balanced means you're drawing (roughly) as much air in as you are pumping out, while a positive setup means you're drawing more air in than you're pumping out. Positive, in theory, stops dust entering through unfiltered areas, while a balanced system is better for airflow and temperatures. We're talking four or five degrees at most. Try both: Using benchmarking tools, put your system under strain, read the resulting temperatures and decide which you prefer.

TIP 4

Fan orientation

Fan orientation — we all slip up from time to time. So what's in and what's out? In short, you can always identify the back of the fan (the area air is being pushed out of, as opposed to drawn into) as the part of the fan with the fan guard attached to it. If that doesn't help, it's the part that the fan cable typically comes out of.



Accessorise your cooling

OK, we're talking about RGB. Why, when it's something we actively try to avoid? And how is it related to cooling? RGB fans are all the craze now. We've seen plenty of LED fans in the past, but they typically only featured one colour and not the crazy cornucopia of rainbows that are now the norm.

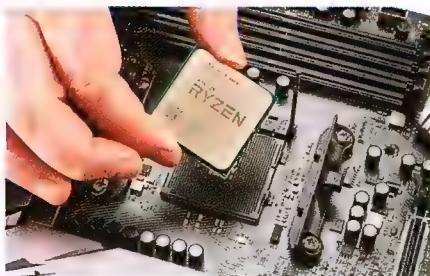
We get it: Some folks enjoy being able to light up their rig in all sorts of weird and wonderful ways. But when you're trying to do it with fans, you have to include an additional cable that connects elsewhere (either into a fan controller, an included RGB controller module, or directly on to the motherboard). That's another cable to route, and added bulk to work around the back of your rig.

It's something you need to take into consideration if you plan to invest in these things. As far as performance is concerned, there's a minimal impact on the fans. Admittedly, some blades do have to be constructed from a more transparent polymer, to allow the LED light to shine through, but that's all there is to it. Static pressure, airflow variants — they're all there, albeit not to the standard of some of the more premium offerings.

If you're itching for both performance and the ability to take part in the RGB phenomenon, Phanteks will sell you an RGB fan frame (admittedly, even we think it's cool). Known as the Halos series, they come in both aluminium and plastic variants, and light the blades up in a very smooth pattern while remaining pretty classy in the process. However, they only fit 120mm or 140mm fans at the moment.

General build tips

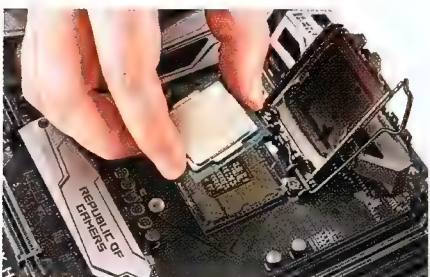
Brushing up on the basics is a smart move from time to time: things change, methods adapt and standards morph.



TIP 1

AMD CPU installation

Outside of Threadripper, AMD has stayed with the PGA (or pin-grid array) setup – the interconnect pins between the motherboard and CPU lie on the processor, as opposed to the motherboard's socket, meaning fewer broken boards. To install your AM4 processor, match the golden corner on the chip with the corner on the socket. Lift the retention arm on the socket, carefully slot the processor into place, push it down firmly in the middle until it's secure, then bring down the retention arm to lock it into place.



TIP 4

Intel CPU installation

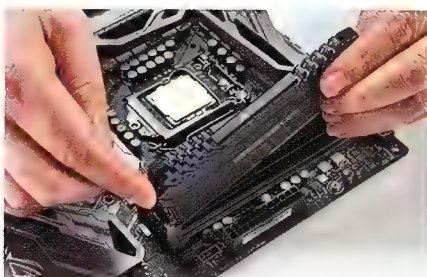
To install any LGA processor, lift the retention arm out and up, then lift up the bracket, leaving the protective plastic covering inside. Line up the processor's golden triangle with the etched triangle on the socket, gently drop it into place, then give it a tiny wiggle to make sure it's secure. Bring the socket bracket back down, securing it under the Torx screw, then bring the retention arm down, and lock it in place. The plastic cover pops off on any LGA 115X platform, but you need to give it a bit of a tug on the 2011 sockets.



TIP 2

Thermal paste application

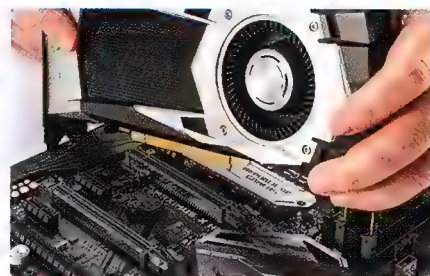
If you're building a Ryzen or Coffee Lake system (or any mainstream CPU build), a small pea-sized dot of paste in the centre of your CPU is all you need. If it's a larger processor, one of Intel's Extreme Editions, for instance, use two pea-sized dots, and three for Threadripper, down the centre. This should be enough to ensure that any CPU heatsink, fan tower, all-in-one, or water block has sufficient thermal interface material to transfer heat away from the CPU die, across to the outer extremities of the heatsinks.



TIP 5

Memory installation

Installing memory correctly is fairly straightforward. Find the notch on the bottom of each stick of memory, line that up with the notch in the memory slot on the motherboard, and carefully push it into place, making sure the clips on either edge of the memory slot are sticking up—these click into place once each stick is secure. Be sure to populate the color-coordinated memory slots, to ensure dual-channel or quad-channel support is operating correctly. If uncertain, refer to your mobo manual.



TIP 3

PCIe installation

When it comes to installing graphics cards and other add-in PCIe cards, first remove the rear PCIe covers from your case. Then, carefully line your card up with the PCIe slot on your motherboard and gently push it into place until it clicks down. Make sure you install your GPU into the topmost PCIe slot for the best performance. There are different lengths of slot suitable for different purposes. PCIe x16 are the longest slots, designed for GPUs. You may find that some slots that look like PCIe x16 slots are actually x8 instead. You can decipher this by identifying whether the pins inside the slot go halfway or all the way to the end.

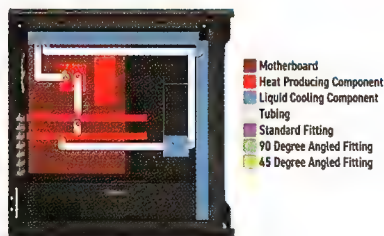
TIP 6

M.2 Installation

Installing the world's latest and greatest M.2 PCIe SSDs varies depending on which motherboard you're installing them on to. Some come with heatsinks, some don't. But the basic theory is pretty simple: Use a small screwdriver to unscrew the tiny Phillips screw that holds the M.2 down, line up the M.2 connector with the slot and push it into place until it clicks in. Then line the end up with the mounting point at the other end and secure back down with the tiny screw. You may have to move that mounting point depending on the length of your PCIe SSD, and there may be an additional heatsink you need to add before resealing it (remember to remove the thermal pad's sticker first), but that's all there is to it.

Advanced build tips

So, that's the basics dealt with, but what about some more advanced tips and tricks for the would-be liquid-cooler, the OCD-oriented cable tweeker, and the avid overclocker? Never fear, we have you covered.



TIP 1

Liquid planning

A fully custom loop is something most PC builders aspire to at some stage. Whether you're keen to try it or not, knowing how to build one successfully is a key piece of knowledge to have. As with most builds, it all starts with a good plan, some acquired knowledge and a touch of research. There are two basic principles to remember when liquid-cooling. Firstly, your pump must almost always be gravity fed by a reservoir and, secondly, each component you wish to cool must have at least 120mm of radiator to support it — more for overclocking. Once you've got that pinned down, it's on to the planning stage. Similar to our first plan we did back on page 50, it's a good idea to use a side-on image of your case, sketch out roughly where your CPU and GPU will be, and work from there. By that we mean decide where to place your radiators, reservoir, and pump (or

pumps, if you're going for dual loops), then figure out how to run your tubing. Visualise your build, understand what direction the coolant will flow, then decide on your tubing runs. For beginners, we recommend keeping it as simple as you can at first, until you get the hang of it. If you intend to introduce a bend to your tubing, it's easier to work one into a long length than a short one, and it's always advisable to use angled fittings wherever possible, to reduce the number of bends you'll have to produce.

TIP 2

Cable management

Good cable management is all about layering. Identify what cables need to run where, then layer them. Most cases have more than enough room in the back to allow for cable management. Zip-tie bunches of them to the back of the motherboard tray, or use the Velcro straps often included in today's cases. Tie down your 24-pin and 8-pin CPU power first, then work on PCIe cables, and anything else afterward. Modular power supplies are a must — minimising the number of cables you have keeps a build tidy.

TIP 3

Pro lighting

Good lighting is hidden lighting. The aim is simple: Anything that produces



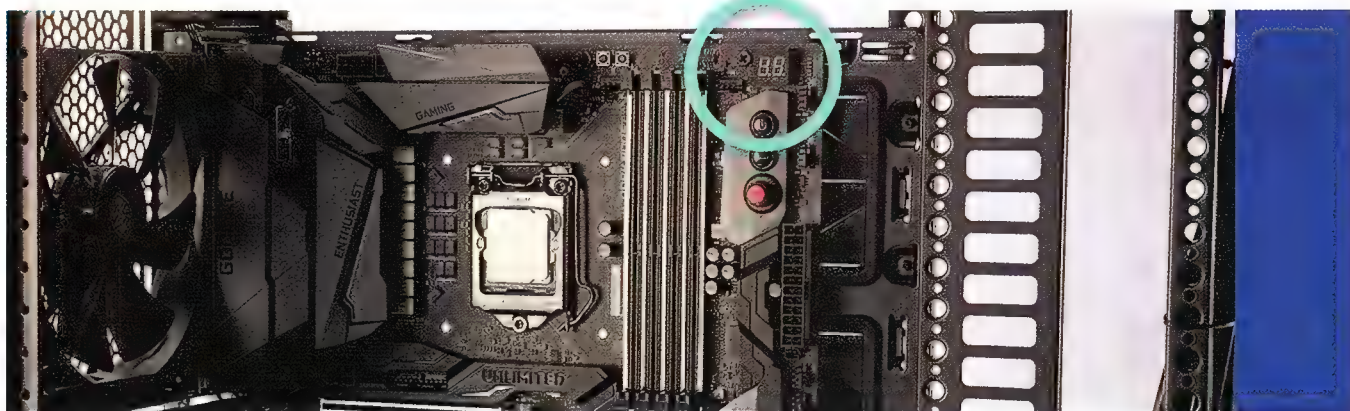
light should be hidden so you can only see the light that is thrown, as opposed to the light source itself. Hiding strips along the edges of cases, hidden by the thick black borders of tempered glass, or along the bottom of a chassis away from prying eyes, is a smart way of achieving this. On top of that, two strips are often better than one. Put one along the bottom and another along the front side, and you'll immediately light up two separate angles, producing a more dynamic lighting effect. Additionally, always go for a white light. Single-colour strips (red, blue, green, and so on) typically drown out all definition and design on components. If a motherboard has red and black accents and you throw a red LED strip in there, all you'll see is red everywhere.

Custom loop costs & myths

It's the big question that's continually asked: is liquid-cooling worth it? At least on a custom scale? Well, that depends. You'll definitely get lower temperatures by taking advantage of that thermal heat dispensing method, but your hardware won't run any faster because of it. The one big advantage is a reduction in overall noise, thanks to the opportunity to run your fans more slowly. However, the cost is huge in contrast to more traditional cooling methods — for a really good-looking loop, you can expect to spend anywhere between \$400 to \$600 at a minimum. Compare that to a well-armed AIO, and it immediately becomes less attractive.

So, is it worth it? You need to consider your available budget and how much you covet silence and cooling. If the answer is "a lot", then liquid cooling is for you. If not, a good old air tower or AIO with some quiet fans may be a cheaper solution instead.





Fixing boot issues

We've all been there: the panic, the tentative push of the On button, the silence of zero boot. Here's a few quick solutions.

TIP 1

It's probably memory

The number of times we've fixed a boot issue due to memory is staggering. A good way to diagnose these conundrums is via the on-board motherboard debug code display. It typically displays a number, depending on the running state of your motherboard. If nothing appears on your screen, and everything's plugged in correctly, check the BIOS debug code for your first hint; 90 percent of the time, it will say it can't detect the memory. Your best bet? Reseat the memory. If that doesn't work, reseat the processor. And if that doesn't work, try moving your memory to the additional memory slots. If you're still not having any luck, it's time to work out whether your memory is DOA. To do this, you'll want to try each stick separately. And if you're still not having any luck, it's probably time to RMA those suckers.

TIP 2

RMA & returns

There's a reason we suggest going with named brands: warranty. EVGA's warranties and customer service are legendary, same goes for Corsair. If you've got an issue, raise a ticket with the customer support team and, given the evidence, it will likely exchange your part for a fresh one. So, if common sense, the manual, or Google fails you, RMAing might be the way to go.

TIP 3

Fresh install Windows

We've also seen our fair share of OS-related issues, especially when transferring old hard drives to new systems. It can be anything from driver conflicts (always uninstall AMD/Nvidia drivers before swapping to the competitors cards), to corrupt OS files, to program conflicts.

Ultimately, we always recommend you do a completely fresh install of Windows on to your SSD — not a refresh, not a reset, but a completely fresh install.

TIP 3

Cables, cables, cables

We've all done it — forgotten to plug in the PCIe power, not attached front panel connectors, had a cheap DisplayPort cable.... You can guarantee all of us here have probably built a system and missed plugging a cable in at least once. Display connection cables, in particular, are chronically bad for this — the number of crappy DisplayPort and HDMI cables we've handled over the years is horrific. In short, make sure everything's plugged in where it needs to be and your system hasn't gone to sleep in the process.

Auto overlocks

Nothing says 'problematic' quite like an auto-overclocking motherboard. We've seen it across multiple generations now, as manufacturers try to differentiate their motherboards from each other. It's pretty prolific with Coffee Lake, as Asus pumps up the default VCore in its motherboards to boost processor performance in benchmarks (in short, enabling more stable turbos at higher frequencies at stock). This is great, up until you start noticing temperature spikes of 20 degrees or more compared to the competition.

We've seen this with memory profiles, too. Early on with AMD memory, frequency support was haphazard across a swathe of motherboards, with 2,400, 2,800 and 3,000MT/s causing boot loops and more. Threadripper still can't support 128GB of DDR4 at 3,200MT/s.

So what's the solution? BIOS tweaking. If you're having thermal issues, check that your heatsink is securely fastened to the motherboard; if it is, adjust the VCore in the overclock



settings. Typically, we recommend 1.2V for most Intel Sky Lake, Kaby Lake, and Coffee Lake products. For memory frequencies, try enabling the XMP settings and dropping the frequency by 200MHz or so to alleviate some overclock conundrums.

Installation protocol

Whether you're building a brand new rig or refreshing an old one with a clean build of Windows, you'll find our invaluable installation guide will leave your system running as smooth as silk.

TIP 1

Update the BIOS

BIOS updates used to be a daunting, leading to bricked motherboards and dead CPUs. Now, it's really beneficial, and we recommend you update your BIOS whenever a new one launches. Go to your motherboard manufacturer's website, find the page for your model and head to the support section. Go to 'driver downloads' and search for the BIOS subsection. Download the latest version. Extract this file on to a 4GB USB stick that's been formatted to the FAT32 filesystem, then plug it into the back of your motherboard, head into the BIOS and find the update BIOS tool in the advanced menus. Select the USB stick, find the file, and load it — your motherboard takes care of the rest.

TIP 2

Fan curves

While you're in the BIOS, take a look at tweaking the fan curves. If you're plugging all your fans into PWM headers, setting a quieter fan curve can reduce noise and make your PC experience far more enjoyable. It varies from board to board, but we recommend you set a low curve (35% power) all the way up until you hit about 60°C, at which point, you can start ramping up those curves.

TIP 3

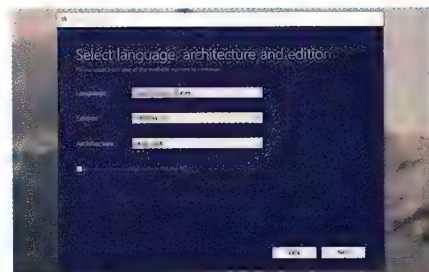
Installing Windows via USB

Installing a fresh copy of Windows 10 is fairly simple nowadays, especially if you've kept your digital key, or your Windows 10 licence is linked to your Microsoft account. Head to bit.ly/Win10MediaKit, download the Media Creation Tool and Create Installation Media on to an 8GB USB stick. Plug the USB stick into the back of your system, go into the BIOS boot order, and boot from the USB stick. From there on out, follow the prompts. You're asked to sign into your Microsoft account during the installation process; you can do this now, or create a local account and deal with it later. Once logged in and on the desktop, you can type `Activation` into the Start menu, and either log in to your Microsoft account to verify your new install, or insert your Windows code — and you're done. If you have access to the internet, now is a good time to install any updates.

TIP 4

Installation procedure

What's next? Chipset. Head back to your motherboard manufacturer's website, head to support and driver downloads, and download the latest chipset driver for your rig. Once you've got that, download any additional drivers or utilities you may need. For a lightweight build, all you really need is the LAN and audio drivers. Install the chipset first, then hit Restart. Now you can install the rest. Next, grab your graphics drivers. By default, Windows installs an older driver variant through Windows Update. Head to geforce.com/drivers or support.amd.com/en-us/download, and download the latest driver for your card.



TIP 5

Ninite

Finally, it's time to install any programs you need. Ninite (ninite.com) is our go-to tool for the quick installation of essential apps. Choose what programs you want, and install directly to your C drive. Ninite only installs to C, so if you want to keep Steam on a separate drive, pass on that, and install it separately. Once done, you'll be good to go. ■

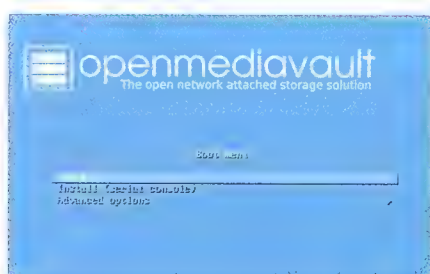
"Installing a fresh copy of Windows 10 is fairly simple nowadays, especially if you've kept your digital key, or your Windows 10 licence is linked to your Microsoft account."



Windows server vs. NAS box

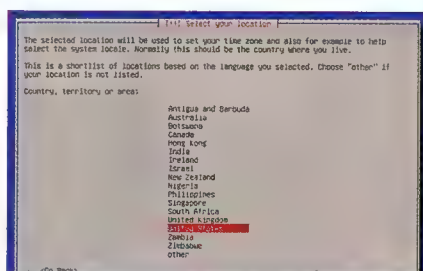
In the blue corner, Windows Server; in the red, an open-source NAS. So which is best for your particular needs?

How to get started with the open-source OMV & network attached storage



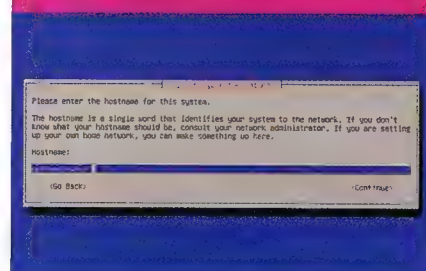
1 GET OPENMEDIAVAULT

We're assuming you're installing this on a blank system — we're not attempting to run anything alongside OMV, dual boot or so on. So we can safely wipe the entire boot system drive. You could run it off a USB stick, but an old sub-64GB SSD would be ideal. We'll add data drives later. Head to www.openmediavault.org/download.html and download the latest ISO file. Currently, that's v4.014 amd64 (64-bit). See the box 'How to instal an OS' over the page, on how to get this on to a DVD or USB drive, and boot from it.



2 START THE INSTALL

If the target NAS PC has booted from your OMV media correctly, you should see an OpenMediaVault boot menu. Ensure 'Install' is selected and press Return. 'Advanced options' has a hardware detection tool, handy for checking if your drives have been correctly identified. If your boot device/DVD isn't detected, see the 'How to instal an OS' box over the page again for options on boot menus and adjusting the BIOS/UEFI.



3 BASIC OPTIONS

Forget your fancy graphical installers, we're kicking it old-school with text-based interfaces. Use the cursor keys to select options. There are some mundane options: Language, Location and Keyboard. Hostname is the name displayed to the network. Use the default for the Domain. Then you need to set a 'root' administrator password; you'll rarely need to use this, but it controls system changes, and remote system log-ins (via SSH), so is recommended to ensure it's secure.

We're riding your easily manipulated machismo as an excuse to look at the pros and cons of using Windows as a home server. The demise of the real Windows Home Server line in 2011 left a hole in Microsoft's range, one that Windows Server Essentials could never quite fill with its small business remit, at a time when, annoyingly, a home server is of more use than ever.

We all have so much digital 'stuff' that we want to keep, access, stream, share and keep safe that it's hard to know where to put it. Sure, there are cloud solutions, but who knows where your data is going to end up being stored. Plus, access speed is always limited by your upstream/downstream speeds. So while throwing stuff up to the cloud is useful, there are limitations and concerns with third-party services.

There's nothing better than having real bare-metal in your locality, running services for high-speed access and backup, from where it can be pushed over slower connections to the cloud if you want. The question is, is it better to run Windows on your home server box, or is an open-source solution preferable? We're here to find out, and explain how to set up your own box.

You know we already know the answer, but we're going to do a fair and

balanced test. By comparing what an open-source network attached server OS can accomplish against Microsoft's Windows 10, we can at least play with something interesting and free.

WHAT IS A NAS?

Network attached storage is, in some ways, an outdated term, because a 'NAS' these days does a whole lot more than just store files. That's the motivation behind this article — can a modern NAS, even a free open-source implementation, take on the might and flexibility of a full-fat Windows box? A huge chunk of that answer relies on what you want from that box.

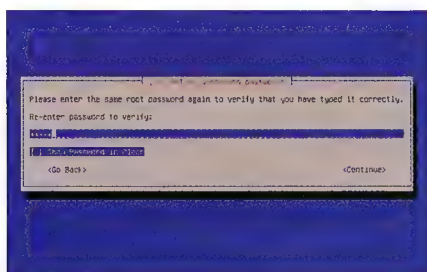
When the term NAS was first coined, people were just happy to easily access remotely stored files (and not get nuked by the Russians), nevermind get any specific additional services. Today, people expect a NAS to provide remote management, file shares with full permissions, print services, a slew of network protocols, virtual machine support, media transcoding, media streaming to multiple devices, supporting tens of storage devices with multi-terabytes of storage, with snapshot and versioning features on top of backups, plus a smorgasbord of flexible plug-in options. But why choose a potentially limiting NAS solution over a Windows install? Let's start by taking time to compare and contrast what both options have to offer.

HARDWARE SPECS

We're going to look at one of the leading open-source NAS distributions, called OpenMediaVault (OMV for short), which is available from www.openmediavault.org. This is up to version 4.0.14 (codename Arrakis, for Dune fans) as of the end of 2017, and only supports 64-bit hardware — older 32-bit hardware needs to fall back to version 3.036, from mid-2016, which isn't ideal. It does support ARM processors, and it has builds for the popular Raspberry Pi 2 and 3, and ODroid SBPCs. Beyond that, requirements are minimal: 256MB of memory and 2GB of drive space. The system is designed to run 'headless', so there's no requirement for video hardware, and it can run from a USB stick. It's based on the Linux distribution Debian, which is one of the best supported and longer running distros out there.

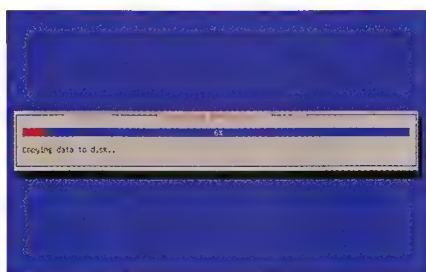
Windows 10 still supports both 32-bit and 64-bit processors, with a minimum speed of 1GHz. 2GB of memory is the minimum for a 64-bit system, while 1GB is required for 32-bit systems. The minimum drive space is 16GB for 32-bit and 20GB for 64-bit systems. Microsoft states a DirectX 9.0 video card is required.

We'd question both of these minimum requirements in a real-world setting, though. Windows is likely going to need at least a 64GB drive,



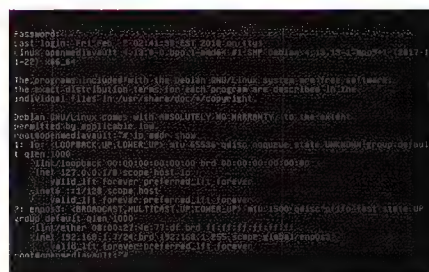
4 ENHANCED OPTIONS

The installer attempts to set the time zone via a network connection. It's likely this will fail, so select a time zone from the presented selection — don't worry, you can adjust this later. Installation initially begins, and you're prompted to select a suitable mirror location. Do so, ignore any option for a Proxy, and wait for the installer. This takes a few minutes; time for a cup of coffee.



5 INSTALL A BOOTLOADER

Do not enter the boot device manually. Choose the generated option below this, it should read something along the lines of: /dev/sda (complex name of your drive). If you hit 'Enter Manually' by mistake, press Esc and reselect the 'Install the GRUB boot loader' option. There's a few more update dialogs, and it prompts you that the installation is done, and it can reboot.



6 IT'S LINUX

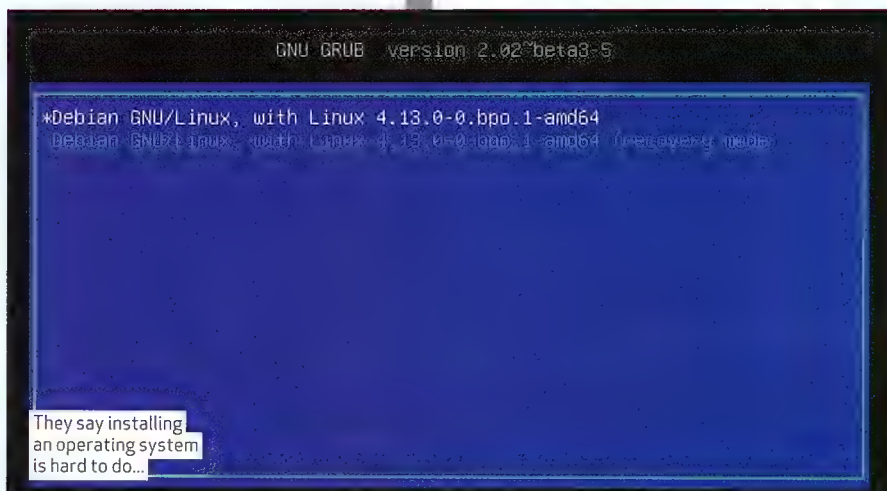
A blank terminal — what now? It's like a choose your own adventure. OMV is designed to be controlled via a web dashboard, and for the 'box' to be run headless. So you need to discover the IP address of the OMV PC. To do this, you could use a smartphone network scanner, like Fing, use a Windows-based scanner, such as Advanced IP Scanner, log into your router and discover the device's IP, or log in to the OMV terminal using the username 'root' and your root password, then type 'ip addr show'. It spits out a bunch of networking nonsense, but the IP address is the second-to-last line, ending with a /24 — something like 192.168.1.10/24.

How to install an OS

Hi. If you're reading this, then you've never installed an OS before. Don't worry — there's nothing to be embarrassed or nervous about, we were all OS install virgins once. Installing an OS seems like something of a dying art; millennials and their damn embedded 'smart' devices — tsk. An OS is software like anything else, it just happens that part of its job is to load the OS kernel and generally boot the system to a usable state, the clever scamp, which means that installing it requires you to boot the system off an install media — a DVD or USB drive, in other words.

At the start of the walkthrough (back over the page), we direct you to download an ISO file of OMV. An ISO file is a standard file format maintained as ISO9660; shout out to our epic friends at the International Organization for Standardization!

To use that image, you need to do two things: burn it or write it to a suitable media, and then boot your target PC from that media. If you have DVD drives (USB DVD drives for the win), you're set, as Windows will just write that ISO to any blank disc. For USB drives, our general go-to software is UNetbootin, from <https://unetbootin.github.io>, cross-platform, open-source ISO-writing goodness.



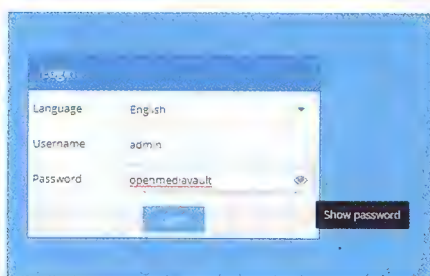
Download, install, fire it up, ignore the Distribution option, jump to Diskimage and select the ISO file.

Now to boot from that media. Many PCs offer an early Boot menu, accessed by tapping a key while powering up: F9 (HP), F12 (Dell, Lenovo), F8 (Amibios), or F11 (Award BIOS). Alternatively, use the BIOS/UEFI to adjust the drive boot order. Again, tap a key during powerup — usually Del, but sometimes F1, or F2. Some UEFI PCs require access via Windows: holding Shift, select its Restart option.

while even OMV is going to work more efficiently with more memory to buffer file transfers, though its storage really remains small.

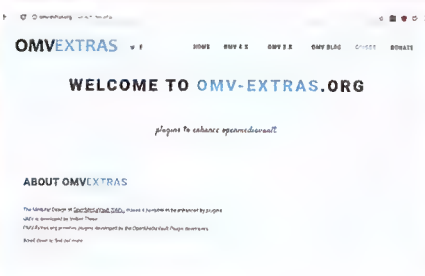
SOFTWARE SPECIFICATIONS

Windows 10 wins here, right? It supports everything — what can beat that? It's a touch unfair to compare Windows 10 Pro against OpenMediaVault. One is a consumer-level OS designed for single-user systems, and the other is based on a multi-user, enterprise-grade, open-source OS.



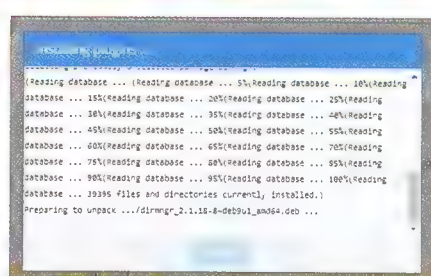
7 WEB INTERFACE

OMV is controlled via a web interface — you log into this via a standard browser, running on any device, connected to your local network. In the browser's address bar, enter the IP spat out in Step 6, such as 192.168.1.10. To log in, the username is "admin" and the password is "openmediavault". Congratulations, you're up and running. You start viewing the Dashboard section, under Diagnostics. All controls are down the left-hand menu, reboot and power controls are in the top-right menu.



8 PLUGINS

Before we configure any storage, we're going to look at the plugin system. You add additional official and third-party extensions via the plugin system, which is basically a wrapper for the Linux software install (package management) system. Under the 'General > Plugin' section, you'll find a number of default bundled official plugins. We need to add the flash-media plugin, which isn't included. Head to <http://omv-extras.org> — this is the official repository for OMV plugins. Click Guides, scroll to Installation, then click and download the 'For OMV 4.x openmediavault-omvextrasorg_latest_all4.deb' package to your PC.



9 INSTALL THE EXTRAS

Back in the OMV interface, select Upload in 'General > Plugins', click Browse, locate the .deb file you downloaded, click OK, and let it upload. Scroll to the bottom of the Plugin list, click the checkbox next to the 'openmediavault-omvextrasorg 4.x.x' entry, and click the +Install button. After a few seconds, the browser reloads, and a new section called 'OMV-Extras' is available. This has added a bunch of extra features, and enables you to easily add new plugins, as we'll see...

Both do many similar basic things out of the box, such as hardware support, user management, scheduling jobs, multi-language support, network support with IPv6, wake on LAN, software RAID, disk quotas, print support and monitoring. The boring stuff. It's the extra boring stuff where OMV tends to excel. For management, OMV delivers a web-based interface. Windows does provide Remote Desktop, but in many ways, it's not streamlined for management, and only supports single-user access. OMV supports network Link aggregation for network redundancy and bandwidth improvements, Windows 10 Pro doesn't.

INSTALLATION AND UPDATES

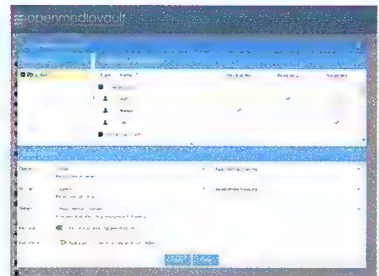
We're going to just say it: OMV wins hands down here. It installs in 10 minutes or so, is up and running, and fully updated in that time. It's licensed under the GPL v3 (copyleft open source), and based on one of the biggest Linux distros, Debian. So as long as the project has developer support, you'll get all the updates and support you need, for free, forever. We think you know where you stand with Windows 10 on these points.

An associated issue with installation is driver support; in the past, you could have claimed Linux suffered from poorer support, but that's rarely the case now. Intel generally puts open-

Windows shares

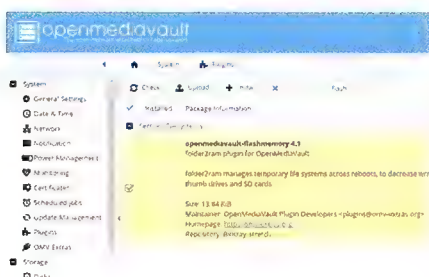
If you've followed the walkthrough, you're at a point where the NAS can be let loose on your network for people to access. The final step is providing shared folders for Windows users to access. This uses the SMB/CIFS, aka Samba, system. Find this under 'Services > SMB/CIFS'. You largely just need to hit Enable, click Save, then click the Shares tab, and add any folders you've created. Click +Add, then Enable, select the Shared folder (we create a public one in step 14), and if it should be available to everyone, enable the 'Public > Guest allowed' pull-down menu. You'll likely need to click 'System Apply' once you've saved the new share's settings. If you jump on a Windows machine and peruse the network, you'll now see a new OpenMediaVault machine, and inside there is the Public folder.

Creating folders with access control is more involved, and Windows can be a bit odd with credentials on occasion.



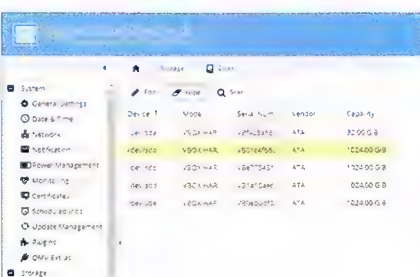
In OMV, select 'Access Rights Management > User', click +Add, and create a user with a password. If you've not already, under 'Shared Folders' create a suitable folder to have restricted access: Click +Add, give it a name, choose the Device and under Permissions, choose 'Admin r/w, Users r/w, and Others None'. Click Privileges, and choose the user and read/write access. Switch to 'SMB/CIFS', click 'Shares > +Add', select your new folder from the 'Shared folder' list, click Save, then Apply.

"Sure, there are cloud solutions, but who knows where your data is going to end up being stored."



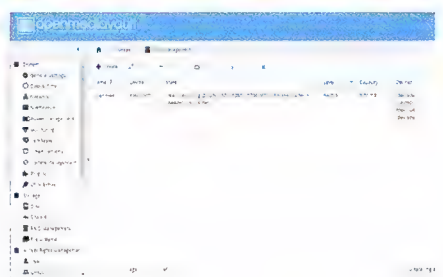
10 INSTALL AN EXTERNAL PLUGIN

If you're running OMV from a flash device, you're recommended to install the flash-media plugin. This reduces direct drive writes to extend the flash life via a memory cache. With the extras installed and a Check run, there's now an openmediavault-flashmemory plugin under the Filesystems section. This reduces the write load on flash media by caching to memory. Click the checkbox and click +Install. With everything set, let's add some data drives and user folders.



11 ATTACH YOUR DRIVES

Power down and connect the drives that you want to store files on. We're going to create a RAID with four drives attached. These all need to be wiped before OMV will allow you to do anything. Select 'Storage > Disks'. Ignore '/dev/sda' — that'll be your boot drive. Select the others in turn, and click Wipe.



12 RAID TIME

Switch to 'Storage > RAID' and click +Create. Give your RAID a name, select the drives you're going to add to the RAID, and if you're not happy with the default RAID mode, choose another. Once done, click Create. The RAID requires synchronising — even though it is blank — and this takes a few hours, depending on the size and speed of the drives. You'll also note the final capacity is somewhat less than the total, which is due to an entire drive being used as redundancy, so if one fails, data is not lost.

Off the shelf

Well, that was all a lot of effort, wasn't it? Surely capitalism can provide an easier solution? Damn right. Off-the-shelf NAS options are available in droves, and provide a level of ease, functionality and slickness that'd be akin to the low levels of friction you'd find between dihydrogen monoxide and a mallard's back. We'd certainly point you in the direction of QNAP and Synology — both offer a range of solid NAS systems, with very flexible web-controlled software and other simple remote management options. You'll be able to manage your NAS from any web browser or your smartphone.

At the low end, drives are typically offered in single-, dual- and quad-bay

designs, with various processor, network, video-out and expansion options. Moving up the levels, you hit eight-bay models, with Core i7 processors, up to 64GB of system memory, dual 10GB networking and beyond.

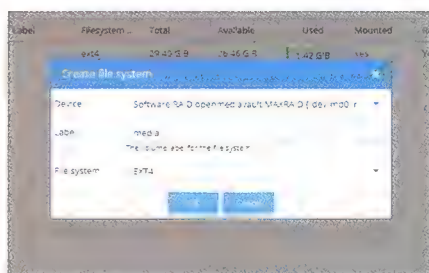
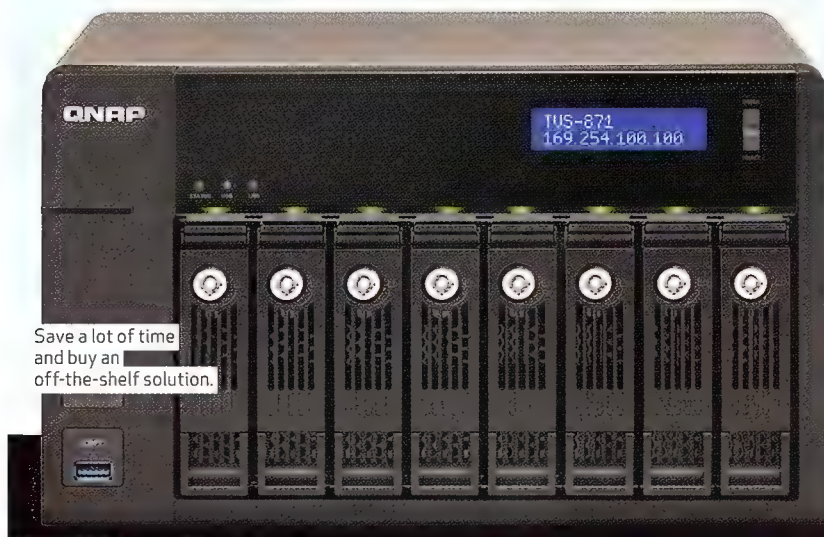
Of course, part of the reason for running this article is the do-it-yourself option. Take an old processor and motherboard, link up a bunch of drives, and you can effectively build your own NAS box. Low-power Core i3 processors provide an excellent option and all the Quick Sync transcoding grunt you could need for most situations.

source driver development first; AMD is pushing its display driver stack to being entirely open source and part of the kernel. The main areas of contention are odd Wi-Fi dongles, but a touch of Google research typically unearths a Linux driver. But, then, printers and scanners can be a pain on Linux, too.

SERVICES AND ADMIN

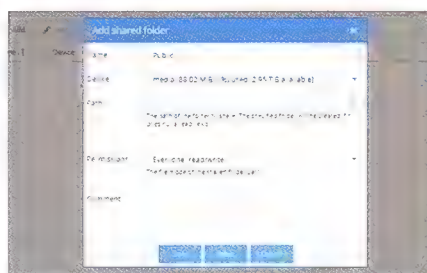
A key differential is how OMV and Win 10 handle services and admin. With Windows, you can support all manner of services through clients, but it's all done with separate interfaces and Remote Desktop, hardly ideal. With OMV, all admin and services are installed and controlled through the same web interface from any network-connected device. It's the headless functionality that enables you to tuck your NAS away at the end of an Ethernet cable that makes everyone's life easier.

While we'd say OMV has a slightly higher entry level of required knowledge over Windows, if you're capable of installing an OS from scratch, you're going to get on with either option. You'll find help in abundance for both, while you'll balance the unbridled flexibility of Windows versus the slick stability and security of OMV. The truth is, we're all winners here; no one is forcing you to use OMV, it's just another tool in the computing armory. ■



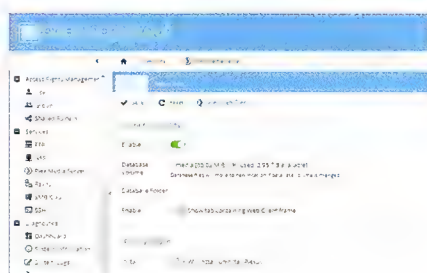
13 FILESYSTEM

Once the RAID is in a clean state, you can add a filesystem to it. Under 'Storage > Filesystems', click +Create. Select your RAID from the Device pull-down menu, give it a name — we're case-sensitive around here — and leave the Filesystem as EXT4. OMV does support advanced filesystems, such as Btrfs, that support anti-bitrot checksums, among other things, but that's way beyond the scope of this article. Once created, select the new drive, click Mount, then Apply.



14 FOLDERS

You'll want to add shared folders to keep different files for different reasons, groups, users, and so on. Have a think about who and how files will be shared and accessed. We'll create a generic Public to begin with. You create shared folders under 'Access Right Management > Shared Folder'. Click +Add, choose a name ("public"), your RAID device, ignore the Path, and choose Everyone for 'Permissions'. For more on network shares and Windows access, see the box above.



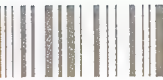
15 MEDIA SERVER

Before we leave you, let's kick a Plex Media Server into action. We'll pretend everything is stored in the public folder (you could create video and music folders). Enable access to the Plex repositories, so we can install it. Select 'OMV-Extras', double-click the Plexmedia entry, click 'Enable, Save and Update'. Switch to 'System > Plugins', search for Plex, select the checkbox, and click +Install — this actually installs Plex. Once done, the web interface refreshes. Select the new Plex control under 'Services > Plex Media Server'. Click Enable, select your main device and Save. Click the Plex Web Client to configure Plex. Happy NASing!



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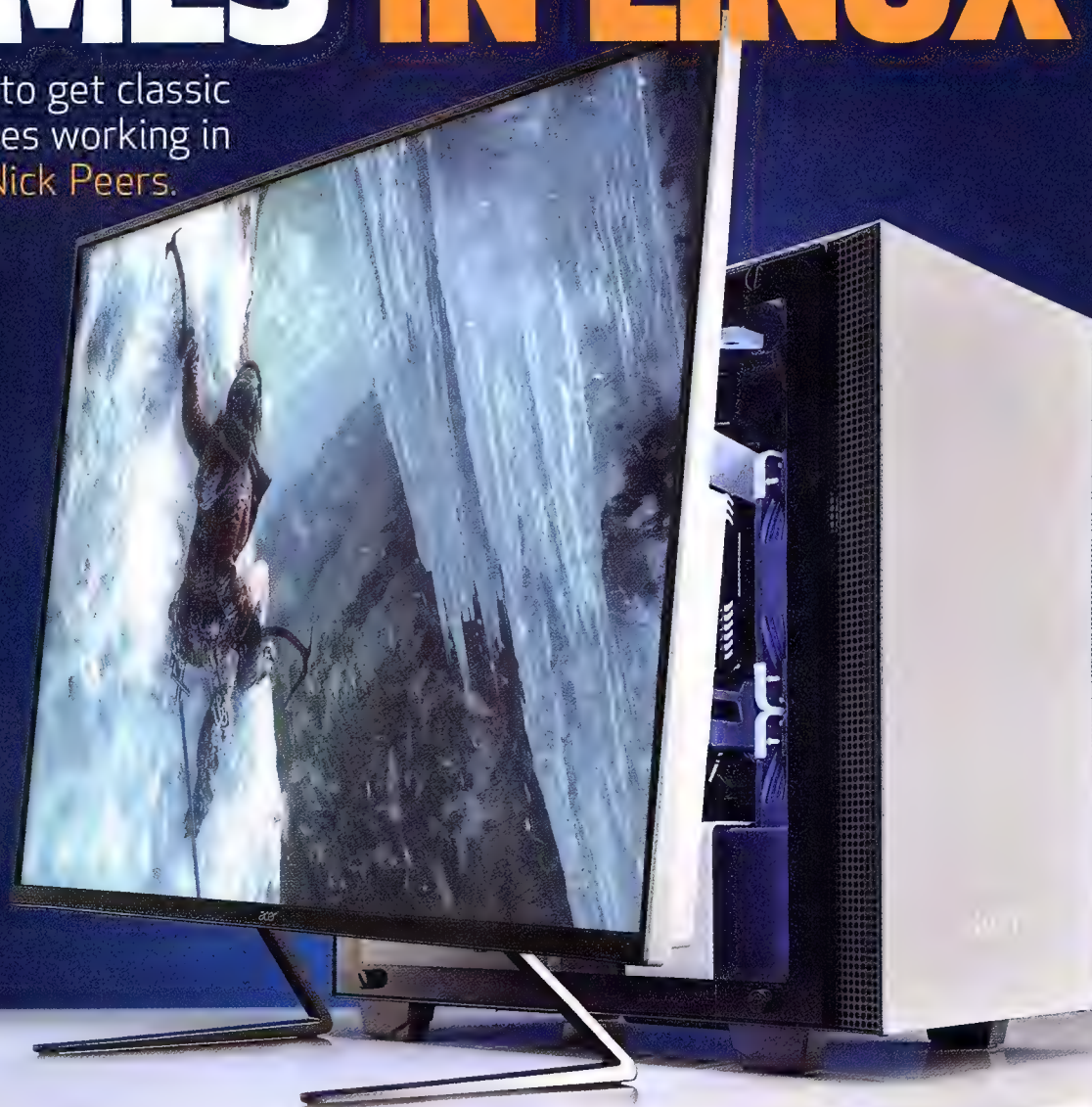
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PLAY WINDOWS GAMES IN LINUX

Discover how to get classic Windows games working in Ubuntu with Nick Peers.



Game developers are increasingly taking advantage of the growing market in Linux gaming, but that's not always been the case, and even now some games aren't released outside of Windows. Thanks to a clever tool called Wine, though, you can run many Windows games – and other apps, including Office – as though they were native to Linux.

Wine provides a skeletal virtual version of Windows, inside which you install extra components and perform various tweaks (for example, selecting which version of Windows you want to emulate) to get your app working.

Sadly, it's not a silver bullet that will get all your Windows games working in Linux, but it should be able to give you access to at least some of them.

The biggest hurdle is that Wine is a command-line tool – great for purists; not so convenient if you want to point and click your way to gaming heaven. Thankfully, others have developed graphical 'wrappers' that sit on top of Wine to make it easier to use from the Ubuntu desktop.

In this guide, we're focusing on one such free tool called PlayOnLinux. Not only does it provide a graphical front end, but PlayOnLinux (or POL to its pals) provides a series of pre-built

scripts that, in theory, make it easy to install and play specific games. As you'll see, in practice that's not always the case, but we'll take you on a tour of the program's features, plus step you through the process of installing through scripts and manually to hopefully get your game up and running.

We'll also explore an alternative Wine wrapper (and touch on another way to play Windows games in Linux), plus reveal how to play old DOS games in addition to Windows classics. So, plug in your game controller, dig out your old Windows discs, and prepare to enter gaming nirvana.

feature » play windows games in linux

For the most part, playing Windows games in Linux involves the Wine emulator. PlayOnLinux (POL) is effectively a more user-friendly front end to Wine, enabling you to configure and access it from outside the command line. Generally, Windows games are played in a 32-bit environment, so if you're running a 64-bit build of Linux, you need to open a Terminal window and issue the following commands:

```
# sudo dpkg --add-architecture i386
```

```
# sudo apt-get update
```

The following steps install the latest version of Wine:

```
# wget -nc https://dl.winehq.org/wine-builds/Release.key
```

```
# sudo apt-key add Release.key
```

```
# sudo apt-add-repository https://dl.winehq.org/wine-builds/ubuntu/
```

```
# sudo apt-get update && sudo apt-get install --install-recommends winehq-stable
```

Note: This is a hefty install – around 800MB – so make sure you have sufficient drive space. Once done, you can move on to install POL itself:

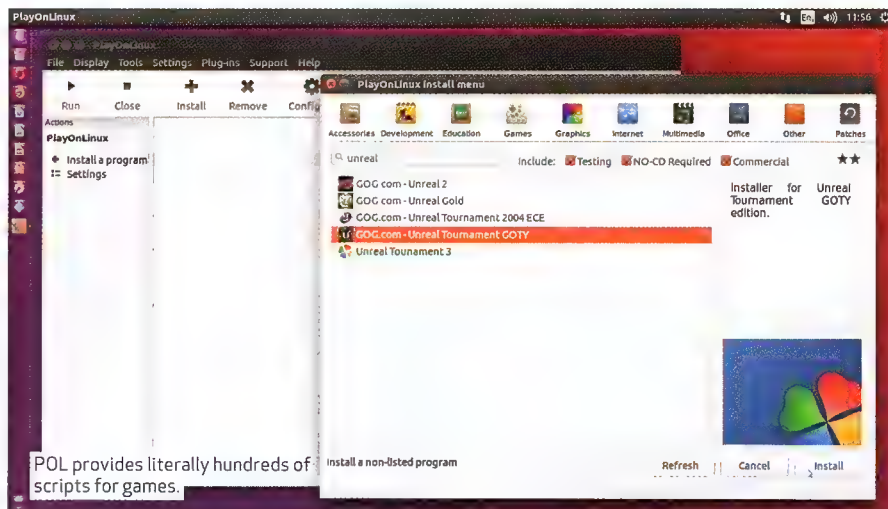
```
# wget -q "http://deb.playonlinux.com/public.gpg" -O- | sudo apt-key add -
```

```
# sudo wget http://deb.playonlinux.com/playonlinux_trusty.list -O /etc/apt/sources.list.d/playonlinux.list
```

```
# sudo apt-get update && sudo apt-get install playonlinux
```

Open Launcher and type PlayOnLinux to launch the app. When prompted, we recommend clicking Yes to anonymously record and share your hardware configuration with POL the first time you attempt to run a Windows program – this helps determine its suitability for similar setups as yours.

The main screen appears and you



might be immediately informed that a newer version is available – if that's the case, go to www.playonlinux.com/en/download.html and save the latest deb file (4.2.12) to your Downloads folder, then open a Terminal window, and type the following to install it:

```
# sudo apt install ~/Downloads/PlayOnLinux_4.2.12.deb
```

```
# playonlinux --version
```

This should now read '4.2.12'. Launch PlayOnLinux again.

INSTALL A SUPPORTED GAME

When the main screen appears again, click 'Install a program' and the install menu appears. Click the Games button to see a list of supported games. Either browse through the list or use the Search button to find a specific game. Some of the games listed require the original disc to run, so make sure that's handy if required.

If you find the game you want, click Install and note the warning: Games should always be installed to 'drive C' of the virtual machine; don't automatically launch the game at the end of the installation if asked; and only reboot virtual Windows if asked to by the program. Click Next.

You're also told how POL isn't related to WineHQ – one additional advantage of POL is that it allows you to install and run multiple versions of Wine at the same time, so if an earlier version is known to work with a specific game, the POL script installs that and uses it automatically. This warning merely points out you should address any problems you encounter to the POL website, not WineHQ. Click Next again.

The installation wizard proper launches – work your way through it as you would with any other Windows program. Step one may be to download a specific version of Wine (and required prerequisites) known to work with the game you've chosen – this is done automatically for you.

Next, you might be prompted to choose the game source. This could be a setup file you've downloaded manually to your PC, a program download (which POL handles for you), a Steam store version (in which case, a virtual version of Steam needs to be installed), or the original game CD.

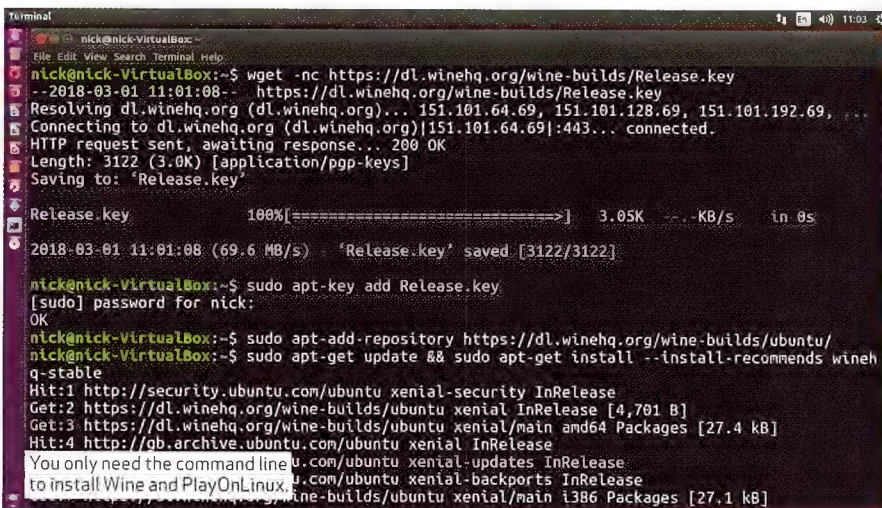
Any known additional prerequisites, such as Microsoft fonts, are now flagged up and installed automatically for you. Here, the automatic wizard comes into its own, highlighting settings and Windows elements you may not be aware of. You might also be asked additional questions, such as how much memory your graphics card has; enter the following in a Terminal window if you're not sure.

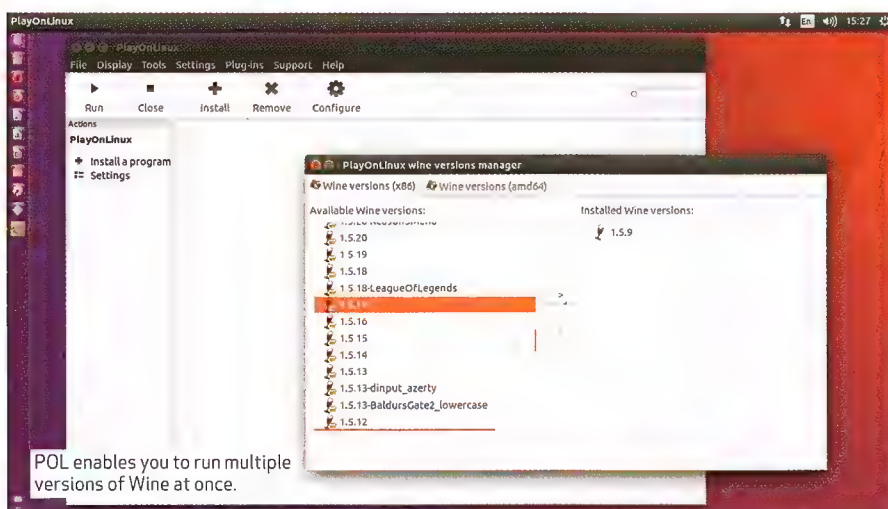
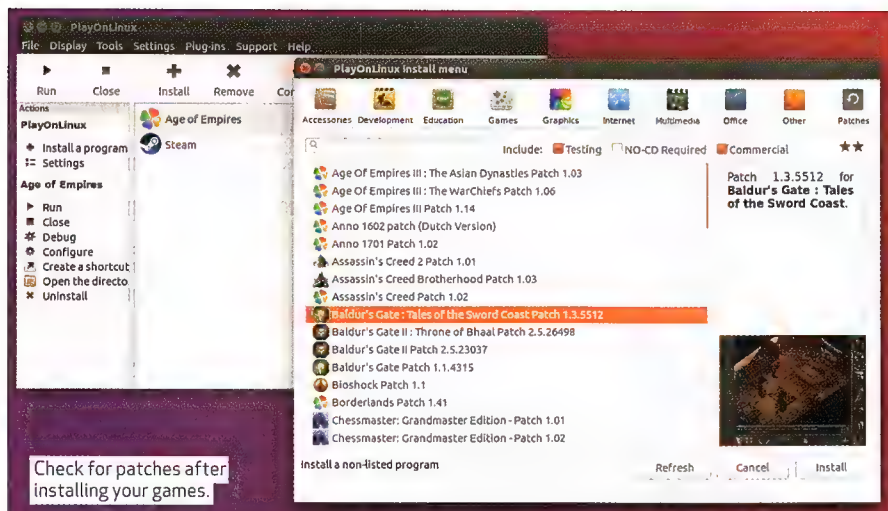
```
sudo dmseg | grep drm
```

If the script continues to run properly, you can now skip to 'Install the game' on page 68.

FIND AN UNSUPPORTED GAME

If you can't find your game listed in PlayOnLinux – or the script fails to work (see the box opposite for a workaround involving Steam-powered games) – don't panic (yet). Head to the Wine Application Database at appdb.winehq.org and type the name of your game into the Search box. Scroll down,





and click the first AppDB result. Note the game's rating: Platinum and Gold indicate the game should work with few problems; Silver and Bronze suggest there may be issues, such as random crashes; Garbage means it won't work. If multiple versions are listed, choose the one closest to your distro and the game.

From here, work through the 'Test Results' and 'Known Bugs' to see how other people have fared, then expand 'HowTo/Notes' to see what guidance there is in terms of prerequisites, which version of Wine to choose and so on. Also check Comments for further information.

In some cases, you receive detailed instructions on what extras to install and how to configure your virtual disk, but sometimes the notes are incredibly sketchy. Try Googling the name of your game along with Wine or PlayOnLinux to see if you can find more information, typically via forum posts from people asking the exact same questions you.

If you're happy there's a good chance the game will work, make sure you have the correct version of Wine installed (you can install multiple versions). In PlayOnLinux, open the Tools menu, and select 'Manage Wine

Versions'. You'll see a list of available Wine versions on the left under the 'Wine versions (x86)' tab. Scroll to find the one recommended and click the > button to install it.

Close the versions manager window, then click 'Install a program', followed by 'Install a non-listed program'. Click Next, then choose 'Install a program in a new virtual drive' and click Next again. Give a name for your game's virtual drive – the game's name should suffice. You're given three optional choices to select: choose a different version of Wine; configure Wine; and install some libraries. Select those you'll need – 'Use another version of Wine' almost certainly – then click Next. If you're choosing a different version of Wine, select it from the list. Click Next. Leave '32-bit Windows installation' selected, and click Next again.

If you opted to install additional libraries, you're given a list of options marked with a POL prefix. They're largely self-explanatory – you'll see many refer to installing additional components, such as DirectX or GDIplus, for example.

If you opt to tweak Wine settings, the Wine configuration window opens.

Install Steam in POL

PlayOnLinux's scripts aren't always capable of getting the job done. There's a particular issue with Steam-powered games where the installer falls over attempting to insert Steam into the virtual drive you've created. The solution here is to first install Steam directly using the POL script. After it's successfully installed, double-click the icon and allow it to update. If you receive an error saying it's crashed, but a progress bar is still running, leave it to finish updating, then click Next to remove the crash window, then log in to your Steam account.

As things stand, Steam works, but is unable to access the store in Ubuntu 16.04 LTS. To resolve this, first select its shortcut in the main POL window, then click Configure. Type the following into the Arguments box on the General tab.

```
-no-cef-sandbox
```

(This constitutes a security risk, just so you know.) Now switch to the 'Install Components' tab, and install the following elements: d3dx9_42, vcrun2008, and xact. You also need to install vcrun2015, but it's not present. Switch to the Miscellaneous tab instead and click 'Open a shell'. Type the following into the shell:

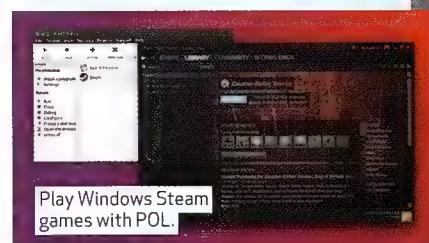
```
# wget https://raw.githubusercontent.com/winetricks/winetricks/master/src/winetricks
```

```
# chmod +x winetricks
```

With the following command, substitute 'username' with your own username:

```
# WINEPREFIX=/home/username/.PlayOnLinux/wineprefix/Steam ./winetricks -q vcrun2015
```

After running, it appears to throw up an error. No matter. Close the window and relaunch Steam. After downloading another update, you'll finally have access, enabling you to download and try to run any games you've purchased.



Play DOS games

Ever wanted to revisit classic games from the '90s? DOSBox enables you to play games written for MS-DOS and, while it's possible to tie it into PlayOnLinux, it's far simpler to just install it natively:

```
# sudo apt-get
install dosbox
# mkdir -p ~/dos/c
```

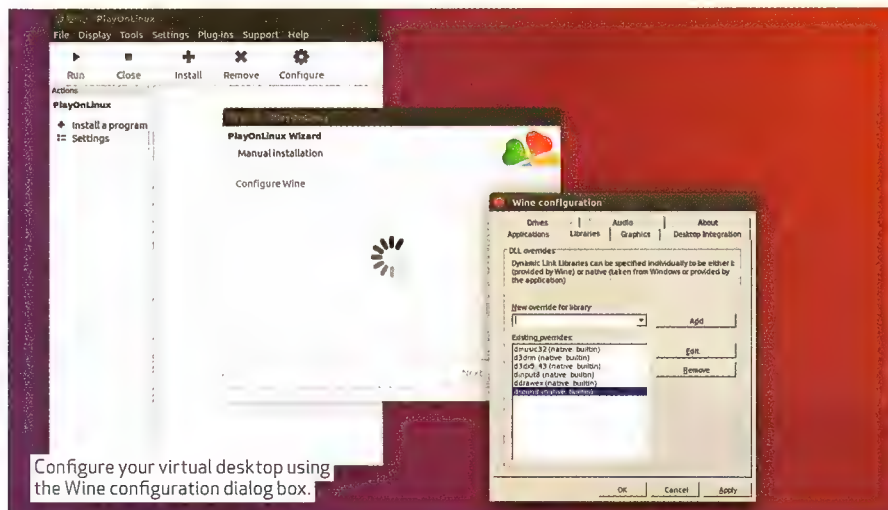
DOS games reside in their own folder and you can source a wide variety from **abandonia.com**. Download a game in Zip format, then extract its contents into the dos/c folder you created in your Home folder.

Now type `dosbox` and hit Enter to launch DOSBox in its own window. Next, enter the following command for it to mount your / dos/c folder as its own C drive:

```
# mount c /home/
username/dos/c
# c:
```

Type `dir` and hit Enter to verify you're in the correct spot. You'll see folders for each of the games you want to run. Type `cd dirname` (for example, `cd civ1` for *Civilization*) to switch directory to the folder, then type `dir` again to identify the game file itself ('civ' in the case of our *Civilization* example). Finally, type the file name, and hit Enter to launch, and play, the game.

If prompted, choose 'VGA (256 colors)' for graphics and SoundBlaster for sound. DOSBox should also work with any basic USB controller recognised by Linux, as well as your mouse and keyboard. When you click inside the DOSBox window, your mouse will be captured permanently. Press Ctrl-F10 to release it back to the main desktop, and visit **dosbox.com** for a full guide to playing DOS games on your PC.



This is split into seven tabs, all of which are largely self-explanatory. Key ones to consider are Libraries, where you can specify DLL overrides for compatibility purposes: Graphics for determining whether the program runs full-screen or in its own desktop window, and Audio for tweaking sound settings, should you need to. Click OK when done.

INSTALL THE GAME

Whether you're installing from a script or manually, the actual game setup process is the same. Hopefully, your CD or DVD will be automatically detected, otherwise click the Browse button to locate your game's setup file – if it's on CD or DVD, select the disc in the Places menu. Locate the file you need to run – try 'setup.exe' if there's no guidance from the AppDB – and click Open, then Next. PlayOnLinux now tries to install the game.

You should see a setup screen from the program itself, which is actually running inside the virtual drive POL created – in other words, proof your skeletal version of Windows is up and running. From here, it's a case of following the game's own wizard through to see whether it's able to

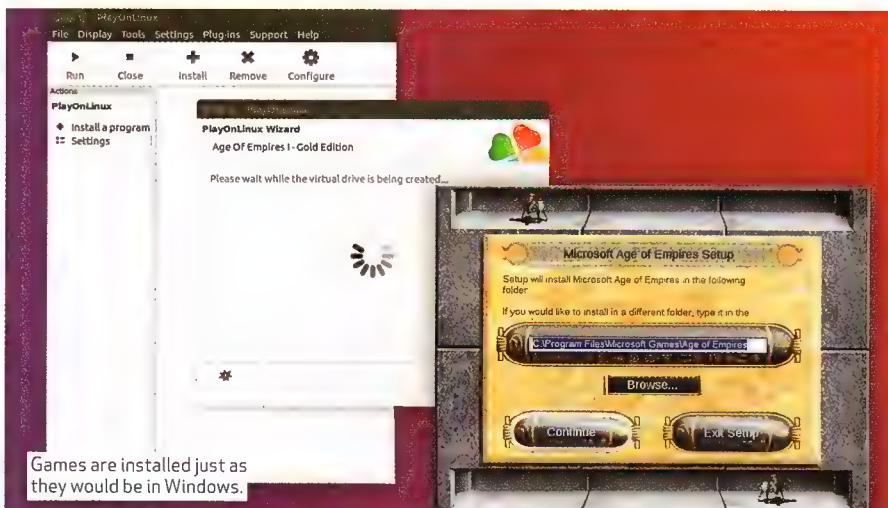
complete successfully – leave the default file location selected when prompted. If errors are thrown up, you may find the game still runs, so attempt to continue to the end if possible by clicking Next.

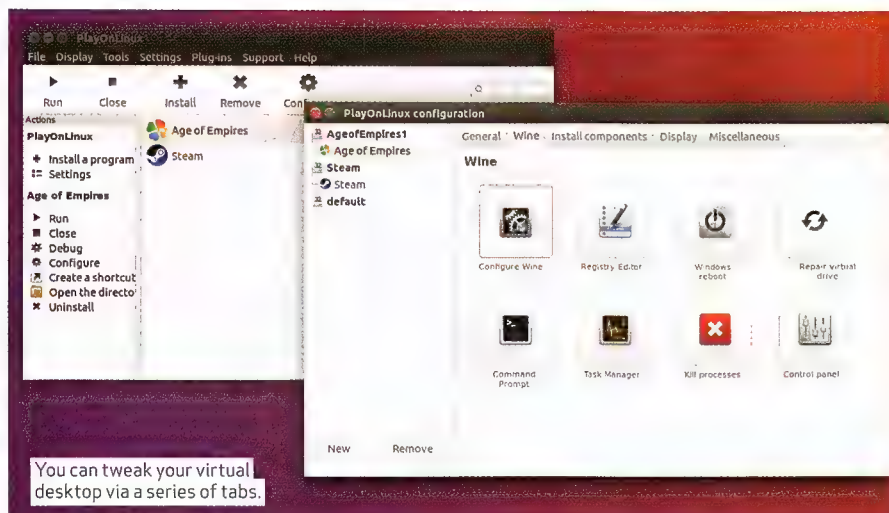
If successful, you're prompted to choose a file that PlayOnLinux will use as a shortcut. Select it from the list, or click Browse if none is provided to hunt your virtual drive for one. It uses the Windows filesystem, so start your search under C:\Program Files. Once done, you're prompted to add as many additional shortcuts as you need. Leave 'I don't want to make another shortcut' selected and click Next when done.

These shortcuts appear on both your desktop and the main PlayOnLinux window; the former enables you to launch your game without having to open PlayOnLinux first, but can be safely deleted without removing the others. You can recreate desktop shortcuts from the main PlayOnLinux window by selecting a shortcut and clicking 'Create a shortcut' in the left-hand pane.

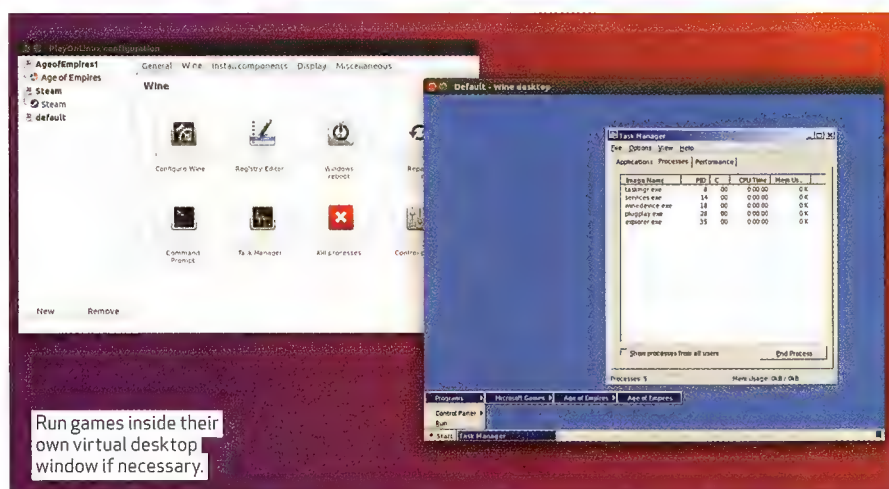
THE MOMENT OF TRUTH

It's time to see how your game plays – if you've installed it manually using





You can tweak your virtual desktop via a series of tabs.



Run games inside their own virtual desktop window if necessary.

a guide from AppDB, you should have forewarning about any potential issues, but your experience may be different. Double-click the shortcut, which should launch the game directly or open Wine Explorer (in which case, click the shortcut again). The game will hopefully launch, and you can start playing it. In most cases, however — particularly if you've installed it manually — things won't be quite that simple, in which case, you may need to dig deeper into your virtual drive's configuration.

First, the game may change your desktop resolution to 640x480 and not reset after it's finished (or crash, leaving you stuck with only the top-left corner of your screen showing). To restore your original desktop resolution, press Ctrl-Alt-T to open a Terminal window, then type the following, and hit Enter:

```
# xrandr -s 0
```

The screen blanks momentarily and your default resolution is restored. To prevent this happening again, try running the game in a virtual window: Click Configure, select your virtual drive, and switch to the Wine tab. Click 'Configure Wine' and wait for the Windows-like multi-tabbed window to appear. Switch to the Graphics tab, and

select 'Emulate a virtual desktop', then set it to the game's resolution: 640x480, 800x600, or 1024x768.

The POL configuration window also offers more configuration options — the Wine tab gives you access to your virtual drive's Task Manager, Control Panel and a Kill Processes option, if you're having trouble shutting it down, for example. Return to the General tab to run arguments when launching your game. The 'Install components' tab enables you to install more Windows components, while Display enables you to experiment with various settings that may or may not fix display glitches. Lastly, Miscellaneous lets you open a shell to your virtual drive or manually launch a Windows .exe file (a setup file, for example, not covered under 'Install components').

As before, these features are quite technical and you're best served by investigating the POL forums and other web resources for help in understanding and using these with specific programs. And if that's too technical, check out the box on the right for an alternative to PlayOnLinux that may not be free, but is simpler to use, better supported and provides working scripts for a greater number of games. ■

Other Linux gaming options

PlayOnLinux isn't the only way to (try to) run Windows software in Linux. As we've seen, POL is basically a user-friendly wrapper for Wine, and while it makes things easier — particularly in the way it supports multiple Wine versions for compatibility purposes — it's not perfect. As you've seen from the main feature, you'll often be forced to bypass its scripts and attempt to wrestle with its controls — in a more user-friendly interface than offered by Wine itself, though — to try to get your game running.

If the idea of Wine appeals, but spending hours trying to get your game working doesn't, take a look at CrossOver Linux (codeweavers.com). Like POL, it's a wrapper for Wine, but it's better developed because, while it's not free, you're paying to support Wine development, and many improvements in Wine have come about through the work of CrossOver's devs.

A trial version is available, giving you ample time to discover whether you'll have more success installing and running your game through CrossOver as opposed to POL — we got *Thief 2* and *Unreal Tournament GOTY* running in CrossOver. The full version can be purchased for US\$39.95 as a one-off cost, or you can pay US\$59.95 for 12 months' updates and personal support to help you try to get your games to run.

Another workaround can be tried if you have access to a Windows license: Install a virtual Windows machine using VirtualBox (virtualbox.org), then install your game in that. Be sure to give it two cores if you can, as well as plenty of RAM — also max out the graphics RAM and select both 2D and 3D support to give it the best chance of providing reasonable performance for your game.



CrossOver Linux works in a similar way to POL.

feature » the spectre & meltdown crisis



The

Spectre



Meltdown

Crisis

Security issues have plagued computing devices in the past, but not on this scale. Darren Yates unravels the Spectre and Meltdown security threats and explains what you need to know



Apple has Spectre and Meltdown updates in macOS 10.13.2.

Everyone knows security issues in computing are as much a way of life as the sun coming up in the morning. Nevertheless, the advent of automatically-installed operating system (OS) updates has rendered many of these security flaws mostly harmless. However, the recent discovery of new 'catastrophic' security threats has unleashed corporate panic regarding the security of everything from phones to laptops and PCs, even cloud computing. So this month, we're delving into the new Meltdown and Spectre threats to understand what they are, how they affect you, why you shouldn't panic just yet and, importantly, what you can – and can't – do to fix them.

WHAT ARE SPECTRE AND MELTDOWN?

These are three variants of a new security exploit recently found in

many computer processor chips. It's 'three' because Spectre is actually two threats (often labelled 'Variant 1' and 'Variant 2') discovered independently by Google's Project Zero and a group of collaborating universities and organisations, including the University of Adelaide and CSIRO-offshoot Data61. Meltdown is the third threat, known as 'Variant 3', and was discovered independently by researchers at Project Zero, Germany's Cyberus Technology and Austria's Graz University of Technology.

To explain what causes these threats, we need to go back briefly to 1995 and look at how computer chips were designed to speed up the processing of computer code. Back then, a computer chip commonly executed computer code a single step or 'instruction' at a time, like following a recipe. However, a technique called 'speculative execution', capable of speeding up code in a roundabout way, was developed.

Not familiar with computer coding? No worries, here's an analogy – imagine you're driving down the road in your autonomous car to your local shopping centre (go with me for a bit on this). To get there, you have to turn off or 'branch' from the current road to reach the centre's location, but there are multiple turn-offs that could take you there. Each turn-off requires the car process a different set of instructions and, to save time (and speed up instruction-processing), the car tries to predict which turn-off you'll choose and processes those instructions for that turn-off ahead of time. Let's say 95% of the time the car predicts correctly, but if you decide on another route instead, the work done to process the instructions for the wrong turn-off has to be tossed and the instructions for your chosen path processed instead. In computer coding, this process is called 'speculative execution'. It aims to predict and execute code branches ahead of time to speed up overall code processing. Intel began using this technique in chips

back in 1995, but by a quirk of fate, it was only relatively recently that separate research groups independently discovered a number of methods for using speculative execution to leak data, such as passwords.

In normal operation, speculative execution runs known code, however, under certain situations, affected processors can be tricked into providing a hole, or 'side channel', through which hackers could tap into data. Of the two major vulnerabilities, Meltdown is said to be the more likely used in an attack, but on the upside, is also easier to fix.

Meltdown taps speculative execution to read the small but high-speed memory inside a processor called 'cache memory'. However, chipmaker Intel says Meltdown can be initially patched with just an operating system update to stop this cache memory leak and will be fixed in future generations of Intel chips.

Spectre Variant 1, known as 'Bounds Check Bypass', can be fixed the same way – through an operating system software patch. However, Spectre Variant 2 is the problem child because it can't be fixed by an OS patch alone. It's officially known as 'Branch Target Injection' and, according to the researchers who discovered it, Spectre enables one program to trick another to look up specific memory locations for data and potentially give up secrets, like your passwords and security keys. In practice, Spectre is harder to exploit, but it's also more difficult to fix.

What's scary is that speculative execution has been used in many processors since 1995, yet detecting Spectre and Meltdown attacks is difficult as they don't leave known footprints.

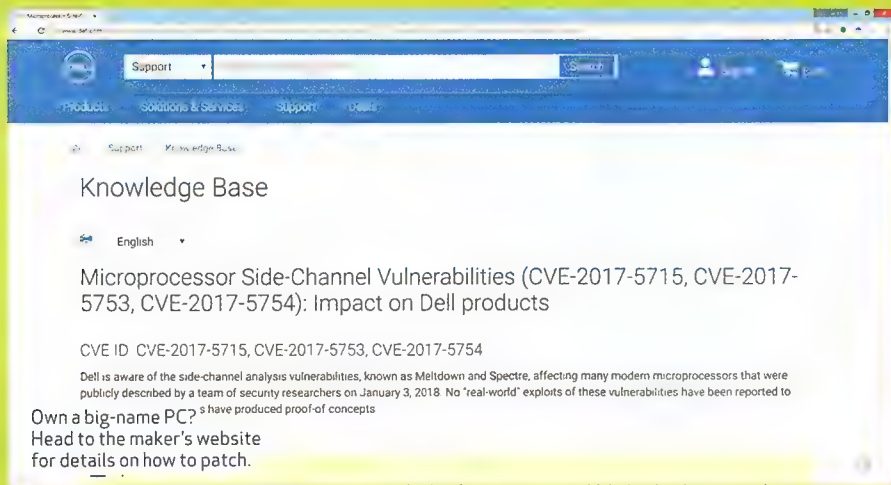
THE FALLOUT

Since news of the issues broke in January, there's been plenty of corporate finger-pointing. As of late February, there were over 30 lawsuits filed against Intel, plus actions against rival chipmaker AMD and Apple. If nothing else, these chip flaws will cast a legal shadow across the computing world for some time.

WHICH DEVICES ARE AFFECTED?

At least for PCs and laptops, software issues are easy to patch. However, what's unprecedented about these vulnerabilities is the scale of the hardware affected. Starting with Meltdown, except for its high-end Itanium processors and the early Atom chips found in netbooks, almost all Intel chips made since 1995 are potentially vulnerable. Some ARM-based phone chips are also reported to be susceptible to Meltdown.

Spectre, on the other hand, affects almost every desktop, laptop, tablet and



feature » the spectre & meltdown crisis



Protect your Windows devices against Spectre and Meltdown

Applies to: Windows 10, Windows 10 Mobile, Windows 8.1, More

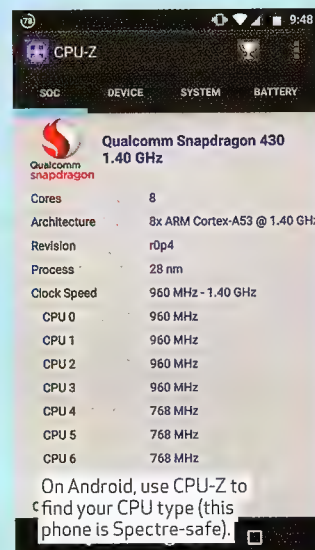
Summary

This article will be updated as additional information becomes available. Please check back here regularly for updates and new FAQ.

This article discusses the impact of the recently disclosed processor vulnerabilities, named "Spectre" and "Meltdown," for Windows customers. This article also provides resources to help keep your devices protected at home, at work, and across your enterprise.

Microsoft is aware of new hardware processor vulnerabilities that are named Spectre and Meltdown. These are a newly discovered class of vulnerability based on a common chip architecture that, when originally designed, was created to speed up computers. The technical name is "speculative execution side-channel vulnerabilities." You can learn more about these

Microsoft has Meltdown and Spectre updates for recent Windows releases.



CPU-Z

SOC DEVICE SYSTEM BATTERY

Qualcomm Snapdragon 430
1.40 GHz

Cores	8
Architecture	8x ARM Cortex-A53 @ 1.40 GHz
Revision	r0p4
Process	28 nm
Clock Speed	960 MHz - 1.40 GHz
CPU 0	960 MHz
CPU 1	960 MHz
CPU 2	960 MHz
CPU 3	960 MHz
CPU 4	768 MHz
CPU 5	768 MHz
CPU 6	768 MHz

On Android, use CPU-Z to find your CPU type (this phone is Spectre-safe).

smartphone — it's even said to affect cloud computing. The scale of this is potentially enormous.

WHICH PHONES ARE AFFECTED?

Looking at mobile devices, chips found in phones, tablets and other gear based on many of ARM's popular 'Cortex-A' series of 'System on a Chip' (SoC) processors are affected. These include, at last count, Cortex-A8, Cortex-A9, Cortex-A12, Cortex-A15, Cortex-A17, Cortex-A57, Cortex-A72, Cortex-A73, and Cortex-A75 series. In simple terms, it covers many devices going right back to 2010, including the original Samsung Galaxy S phone. What makes this more complex is that you may not know which Cortex-A series tech your devices use — ARM doesn't make chips, it designs them and licenses the tech to other manufacturers, such as Apple and Qualcomm, to turn into chips. If you have an Android device, the simplest way to find out which CPU technology your device uses is to install the 'CPU-Z' app from Google Play (tinyurl.com/n4npl4k) and read the answer from the app's 'SOC' page.

However, there is some good news —

if your mobile device runs the very popular Cortex-A53 CPU design only, you're in the clear. Devices with this CPU design, which include, among others, the Motorola Moto G5 series and the popular Raspberry Pi 3 computer, are not affected by Meltdown or Spectre because they don't use speculative execution.

PCS AND LAPTOPS AFFECTED

Unfortunately, the scale of this threat means that rather than attempt to list all of the desktop PCs and laptops potentially affected, it's just easier for you to assume you've got a problem and should take steps to rectify it. If you've bought a big-brand computer, go to the manufacturer's website and start trawling for their Spectre/Meltdown information. Better still, head to meltdownattack.com, the site developed by the Graz University of Technology, scroll to the bottom of the page and you'll find a list of major PC and laptop

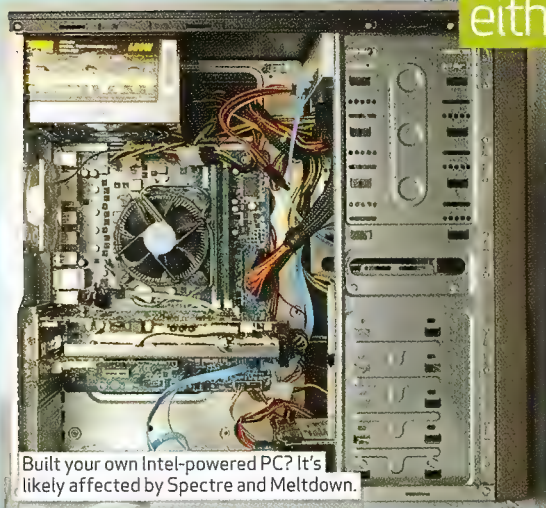
manufacturers, along with news and updates.

WHAT YOU CAN DO

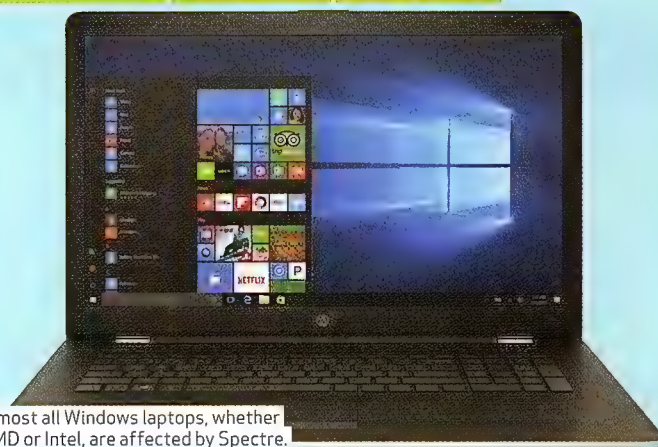
The first step is to not panic — at the time of writing no confirmed attack using either vulnerability was reported, although, as the Graz researchers have said, they can't know for sure because of the way the exploits work. Many tech brands will also happily inform you that exploiting Spectre is difficult to do. Nevertheless, things can also change quickly, so it's not something to be complacent about, either. Here's what we suggest you do.

Start by keeping an eye out for OS security updates for your device and install them as they become available. You'll also need to ensure your anti-virus software is up to date, and be on the lookout for any software updates for your favourite applications, particularly your web browser, as it can be used in an attack.

"The first step is to not panic — at the time of writing no confirmed attack using either vulnerability was reported."



Built your own Intel-powered PC? It's likely affected by Spectre and Meltdown.



Almost all Windows laptops, whether AMD or Intel, are affected by Spectre.

New system software available.

New version NPP25 137-93

Highlights of this update include:

- Android security updates up to 01 November 2017.

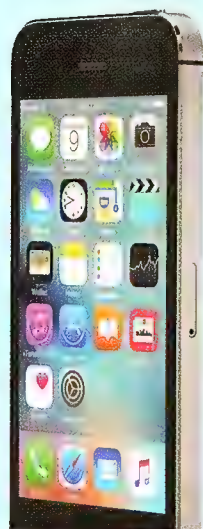
- Stability improvements.

For more information about the update, [click here](#).

To check for updates at any time, go to Settings > About Phone > System updates.

Plug the phone into a power outlet and connect to a high speed network or Wi-Fi.

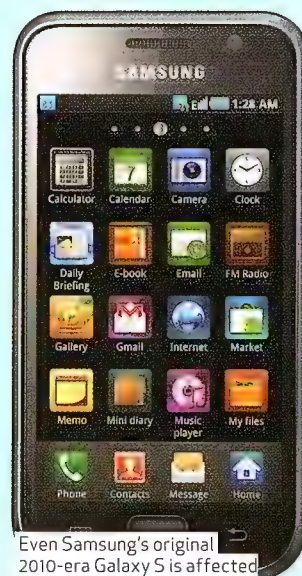
Check Android's System ^{MIN} Updates for any security patches and install them.



The iPhone 5s, the oldest Apple device to receive Spectre/Meltdown patches.



Samsung's Galaxy S6 is likely the oldest Galaxy phone to be patched.



Even Samsung's original 2010-era Galaxy S is affected by Spectre.

Microsoft has OS updates for Windows 10, Windows 8.1 and Windows 7 available now, but if you're still using Windows Vista or XP, be warned — Microsoft will not be issuing fixes for these older operating systems, citing system instability and application compatibility issues that would result from the changes required.

However, operating system and application updates will only fix Meltdown and Spectre Variant 1 — the more complex issue will be updating the hardware microcode, or 'firmware', for Variant 2 and this is already proving a tricky task. Chip giant Intel released emergency fixes for its latest chips in the first week of January, but then pulled them two weeks later after learning users were experiencing unexpected rebooting and system performance degradation. Since then, Intel has been releasing new microcode updates in batches, fixing more recent chips first. So far, the Intel chip families codenamed Skylake (Core iX-6000), Kaby Lake (Core iX-7000) and the brand-new Coffee Lake (Core iX-8000) received firmware updates in mid-February, with older Broadwell (Core iX-5000) and Haswell (Core iX-4000) chips getting theirs at the beginning of March. New updates for even older Ivy Bridge (Core iX-3000) and Sandy Bridge (Core iX-2000) chips were still in beta at time of writing, but possibly have been released by the time you read this. If you're still rocking an Intel-based system older than Sandy Bridge, we probably wouldn't hold out much hope of an update.

By contrast, AMD says its chips are not vulnerable to Meltdown. That said, it does appear AMD CPUs are affected by Spectre and, like Intel chips, will require both software and firmware patches to fix.

Given the initial firmware missteps, we suggest a 'watch and wait' approach

— watch for any firmware updates for your system and, only if you feel confident, wait a day or two just to see if any major issues develop with them first. If not, then install them. If you can't wait, or new specific attack threats are revealed in the meantime, you might want to install the updates regardless.

LOSS OF PERFORMANCE

Installing these updates comes at a cost — Microsoft says if you're running Windows 10 on a Skylake/Core iX-6000 series or newer Intel chip, you should barely notice the dip in system performance. On pre-Skylake systems, though, the performance decreases will likely be more noticeable. What's more, the speed reductions are said to be workload-dependent — some apps won't change, others will cop a more significant dent. Not what we'd call an 'ideal solution'.

UPDATES FOR MOBILE DEVICES

If you own an Apple iPhone or iPad, your device is very likely affected by both Meltdown and Spectre. In response, Apple has released software fixes, but you need iOS 11.2 to overcome Meltdown threats and iOS 11.2.2 for Spectre. Devices not able to update to these releases appear to be out of luck. Still, the updates cover everything since and including 2013's iPhone 5S, iPad Mini 2 and iPad Air.

The situation for Android-powered devices, however, is more complex. Google released fixes to cover Meltdown and Spectre in its January 2018 security patch, but as Android users will know, Google can release security updates, but it's up to device makers to push out 'over-the-air', or OTA, updates to users to fix those issues. Summarising the reports we've seen so far, we think that if a device does not already have an official firmware upgrade path to at least

Android 7.0/Nougat, it's unlikely it'll receive an Android Meltdown or Spectre security update from the device manufacturer. If that's your boat, the very least you should do is update your web browser to the latest Google Chrome 64, which Google says has been patched to reduce the effects of Spectre and Meltdown. However, that still leaves the rest of the device — in that situation, we'd refrain from doing any mobile banking or other personal data-heavy activities on that device. Nevertheless, fire up your Android device, open Settings, select 'About phone' and tap 'System Updates'. If you're offered any, install them.

BE INTERNET-SMART

Despite all of this, the good news is — no offence — you are still likely the biggest worry from a security viewpoint. Spectre and Meltdown can't attack out of thin air. At the very least, they require you to either install dodgy apps or visit dodgy websites for malicious software code to find its way onto your device. So unless you know the origins of the website or software, stick to Google Play or Apple's App Store for your apps and steer clear of dodgy websites.

WATCH THIS SPACE

Unfortunately, there's no happy ending to this story. Some reports suggest it could take months before complete fixes are available, let alone delivered to your device. Security vulnerabilities on this scale are unprecedented and coordinating resolutions between multiple hardware and software vendors could become a drawn-out affair. While it's important to remember that no known attacks have been launched using Spectre and Meltdown at time of writing, the situation could evolve rapidly. That's why you'll need to keep an eye on this unfolding drama over 2018.

howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

INTERNET

BROWSER ADD-ON HIJACK

I was looking for a browser extension to capture a screenshot of an entire web page and settled on Fireshot, but after a recent update I've found it's now somehow installed itself to my Taskbar Notification area. How do I now get rid of this?

Tim Ellis

This is rather sneaky behaviour, as Fireshot has added a desktop instance of itself, which basically runs whenever your browser is open. You can close this manually without closing your browser via its Taskbar Notification area icon, but you can't remove it permanently.

If this is a dealbreaker – it was for Tim as the program hijacked key shortcuts from other programs – then you'll need to remove Fireshot completely. Tim was using Firefox, so we instructed him to type

'about:addons' into the Address Bar. Locate Fireshot and click Remove, restarting Firefox to complete the process.

Ian Sleightholm

INTERNET

CAN'T BLOCK SPAM WITH FILTER

Spam always finds a way of evading spam filters, so I've set up rules for dealing with unwanted mail using trigger words in the subject line. But somehow these words aren't being detected and email keeps coming through. Can you explain why and how to fix this going forward?

Ian McAndrew

Outlook's junk mail capabilities are no longer that effective thanks to Microsoft no longer updating its SmartScreen spam filter as of November 2016. Try running the rule manually – if it works, then the rule itself may have corrupted (try

deleting and recreating it), or you may need to delete and recreate the Send/Receive settings file. To do this, close Outlook, then press 'Win-R', type %AppData%\Microsoft\Outlook and hit Enter. Rename the .rsr file you find inside with an .old extension. Then restart Outlook and try again.

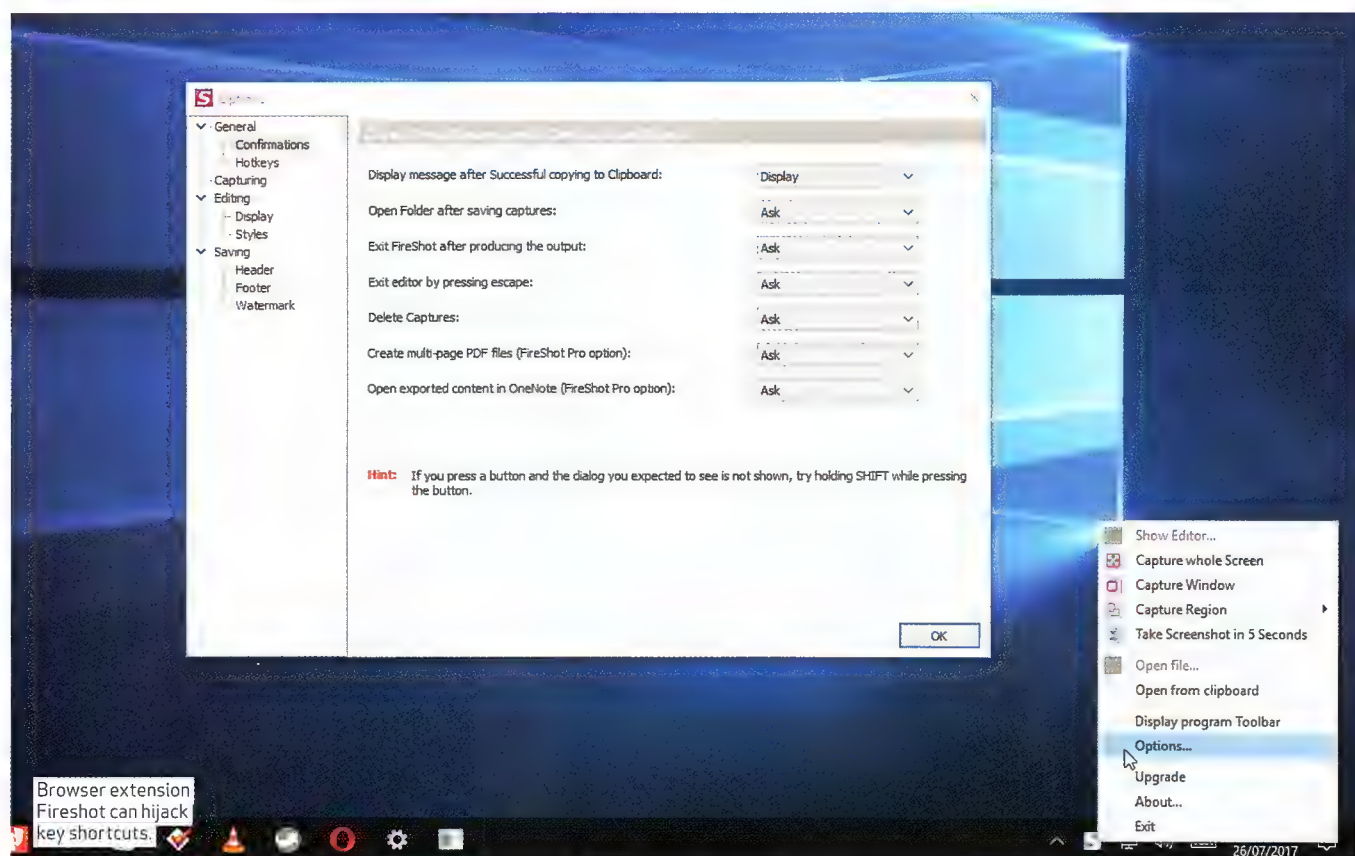
If this doesn't work, or you want a more effective spam-blocking solution, then investigate a third-party mail cleaning tool such as Mailwasher (www.mailwasher.net) or PopTrayU (poptray.sourceforge.net), which blocks spam at the server level – and is a more effective way of keeping it from your mailbox.

Cat Ellis

SECURITY

RANSOMWARES AND NETWORK SHARES

I back up a fail-safe copy to my networked hard drive, but I have learned it may not be



immune to a ransomware attack. What can I do to protect it?
Alice Thomas

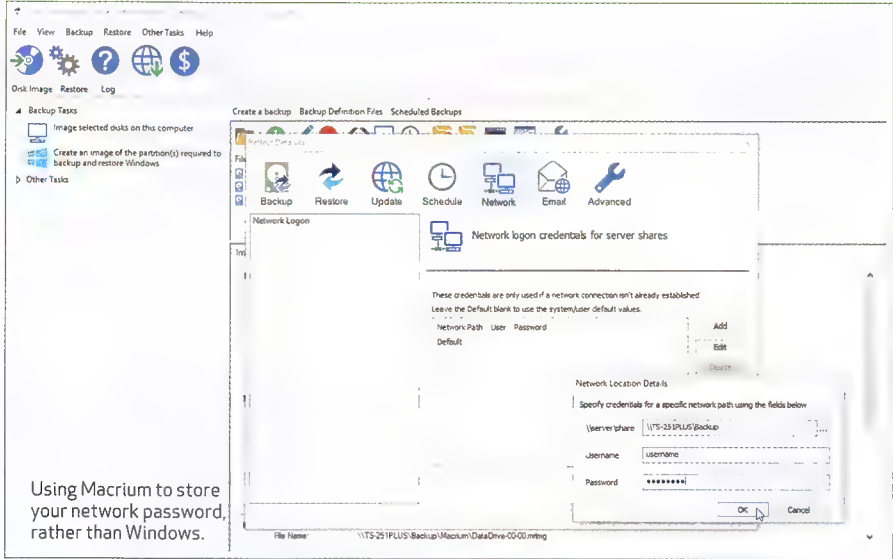
The best way to prevent ransomware from infecting any network shares is to make sure that your network credentials aren't stored in Windows. This is a two-step process – first, make sure your Windows user account doesn't have access to the network share in question (in other words, create a dedicated username and password for accessing that share – easier to do when logging on to a NAS drive). And second, when you log on to a network share, resist the temptation to tick the box marked 'Remember my credentials' – you'll have to manually enter a username and password each time you log on, but it reduces the share's exposure to potential infection. If you currently have saved network credentials in Windows, you can easily remove them: type 'credentials' into the Search box and then click 'Manage Windows credentials' to access the built-in Credential Manager tool. You should see entries for each saved network password under 'Windows Credentials' – next, click the 'v' button followed by 'Remove > Yes'. This should clear it. If you're backing up to a network share, check to see if your backup tool can save those network credentials independently of Windows – for example, in Macrium Reflect, select 'Other Tasks > Edit Defaults > Network' tab. Click Add to manually add a network path, username and password and then click OK twice. You can now back up without exposing your network share to ransomware.

Nick Peers

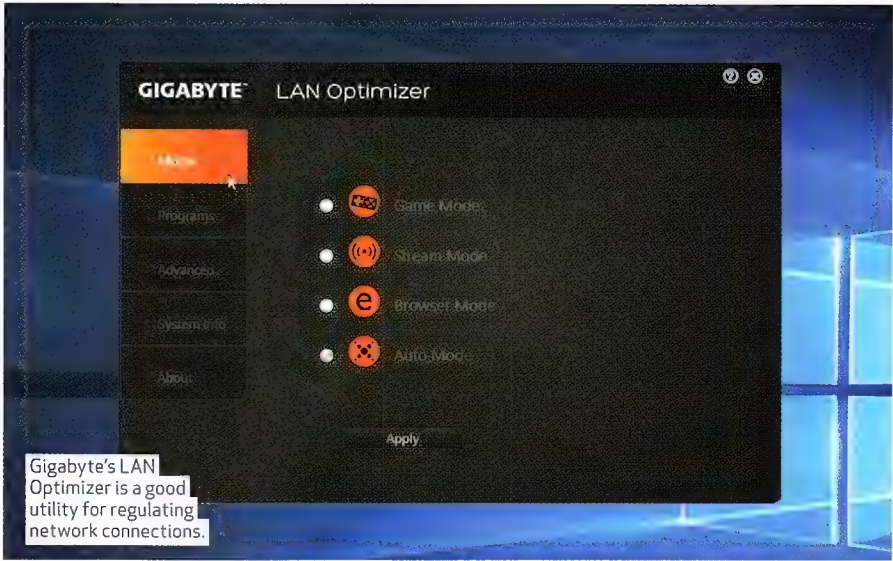
INTERNET
RANDOM INTERNET CONNECTION PROBLEMS

I have a problem whereby my internet connection appears to stop working or otherwise slows down – there's no pattern as to when it occurs and it's particularly noticeable when downloading images in emails or from the internet. Can you help me resolve this issue please?
Connor Hatton

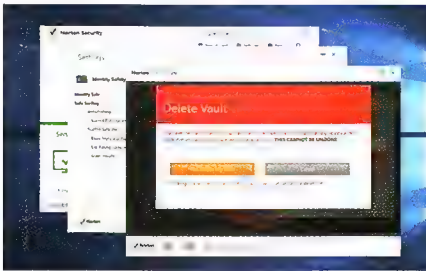
We answered a similar question a couple of years ago. We asked Connor what motherboard he had installed – it was a Gigabyte. You can see which motherboard is installed in your computer using the free Speccy system information tool if you don't already know – get it from www.piriform.com. We then checked whether Connor had installed Gigabyte's LAN Optimizer (www.gigabyte.com/MicroSite/300/lan-optimizer.html), which is used to regulate network connections. Disabling this immediately improved matters. The program has a reputation



Using Macrium to store your network password, rather than Windows.



Gigabyte's LAN Optimizer is a good utility for regulating network connections.



You need Norton Internet Security to help recreate your vault.

for disrupting internet connections and not performing as it should, so Connor was happy to remove the program and finally fix the problem.

Ian Sleightholm

SECURITY
CAN'T DELETE AN IDENTITY SAFE VAULT

I set up a Norton Identity Safe a while back, but did nothing with it. I've forgotten the password, but despite following the advice online, I can't see an option to delete and recreate the vault from scratch after failing to enter the correct password three times.

Can you help me please?
Kyle Watkins

It sounds as if you're trying to log on through your web browser, Kyle. Although it's not mentioned in the support article, you can only reset the vault using Norton Internet Security – the desktop version of Identity Safe was recently discontinued. If you're a Norton user, open the main application, then click Identity followed by Identity Safe. You'll be prompted for the password – entering it incorrectly here will enable you to delete the vault and create a new one with a fresh password. You will need to re-enter your Norton account password as part of the vault creation procedure. If you're not using other Norton products, we'd recommend ditching Identity Safe for LastPass (www.lastpass.com) or KeePassX (www.keepassx.org) instead, choosing the latter if you're uncomfortable storing your passwords in the cloud.

Rob Mead-Green

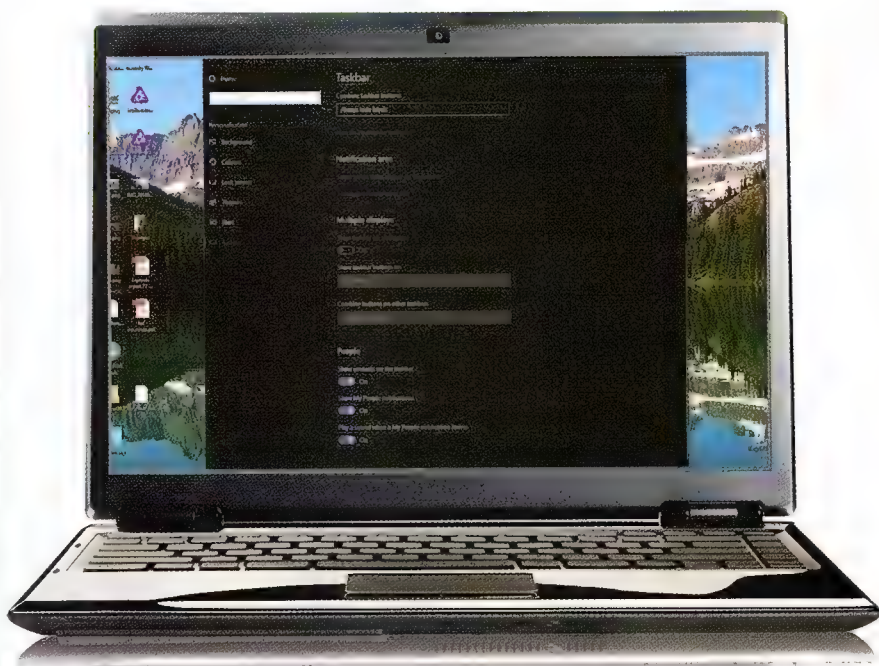
Organise your contacts in Windows 10's People app

Manage your contacts and pin them to your Taskbar with Windows 10's upgraded People app and Ian Evenden.

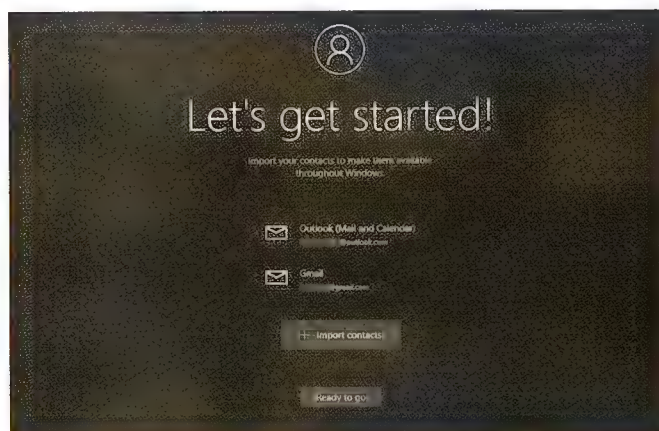
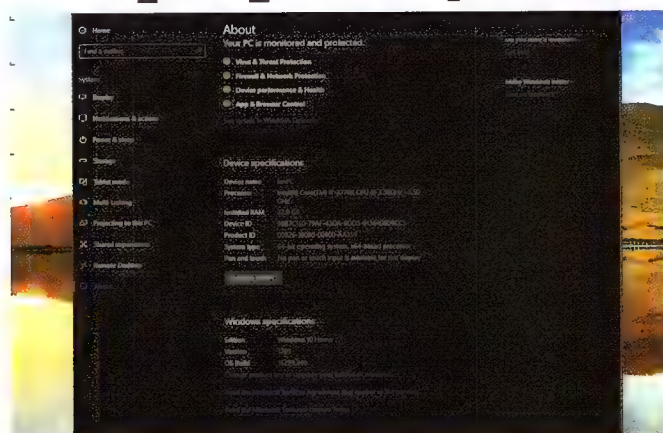
Your Windows PC is a powerful communications tool, but over time your contacts can get spread around across various apps and services. Wouldn't it be convenient if they were all in one place on your PC? That's what Microsoft is trying with the People app, which arrived in Windows 10 along with the Fall Creators Update – although it was supposed to come with the previous Creators Update, earlier in 2017.

The People app is a simple enough idea; merge your contacts from multiple accounts, then make them more accessible to you.

The People app also has an organisational use, enabling you to combine duplicate contacts from disparate services, meaning you can link someone's email address with their Skype alias if they're separate, making it easier to ferret out the contact information you need.



Pin people to your Taskbar

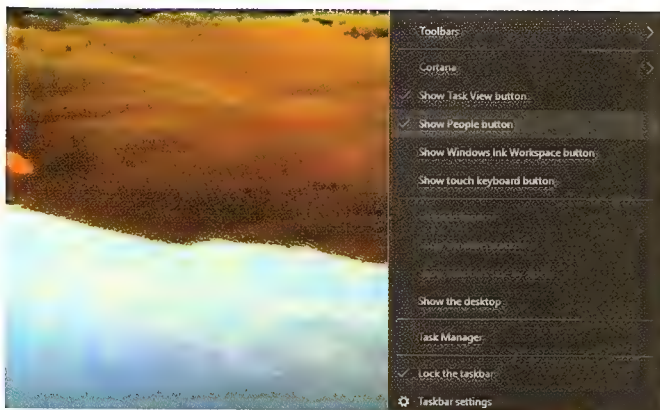


1 GOT THE RIGHT VERSION?

This won't work unless you've installed the Fall Creators Update. To check, open the Start menu and choose 'Settings > System > About' to check your version number under 'Windows specifications'. If you're running the right version, go back to the Start menu and start typing "People" in the Taskbar search box. When the search results appear, select the People app to run it.

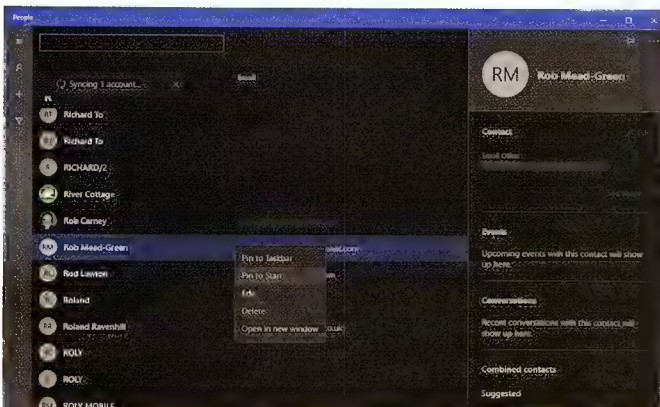
2 LINK YOUR ACCOUNTS

If this is the first time you've used the People app, you'll be prompted to link it to your accounts so it can import your contacts. The default accounts are those you've set up in Mail and Skype, and these can be quickly synced to the People app. Select Import Contacts, and soon you'll see your contacts in the People app, from where you can combine, edit, delete and manage them.



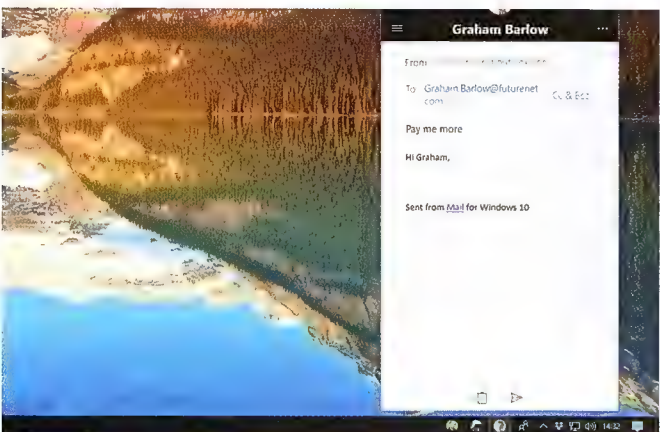
3 MY PEOPLE

People may be an app, but My People is what Microsoft calls an 'experience'. Simply put, My People is the ability to pin your most frequent contacts to the Taskbar, so they're more accessible. If you can't see the People button to the right of the Taskbar (it looks like two board game counters standing in a diagonal line), right-click the system tray and select 'Show People button'.



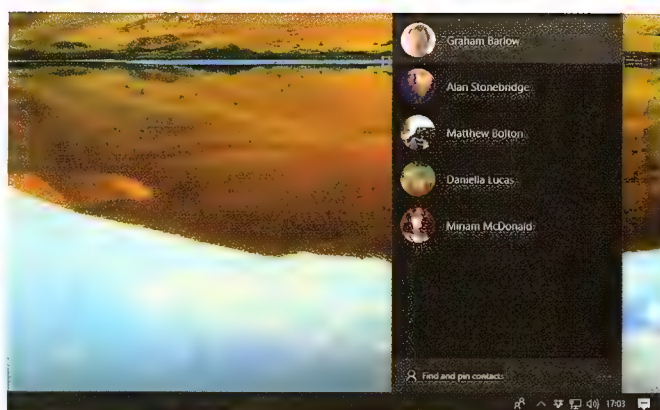
5 MORE PINS

Any other contacts you choose to pin appear in the pop-up menu, in a section called More Pinned Contacts. There's another way of doing it that's slightly more flexible – open the People app, right-click a contact, then choose whether to pin it either to the Taskbar or the Start menu. Choose the latter, confirm the pin, and a tile will appear on your Start menu that you can click to open.



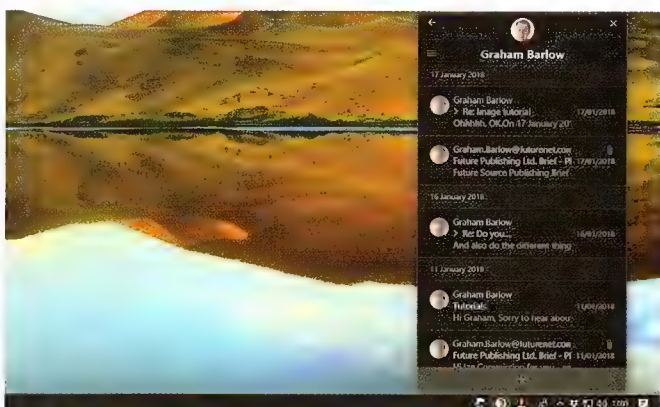
7 SEND A MESSAGE

You can use My People to send a message without opening the full app, such as Mail. Select a contact, click the three-line menu and select Mail. This lists your emails, along with a '+' button at the bottom to create a new message. Write your email in the pop-up menu, and either send it or discard it using the buttons at the bottom. Again, it will stick around until you close the menu.



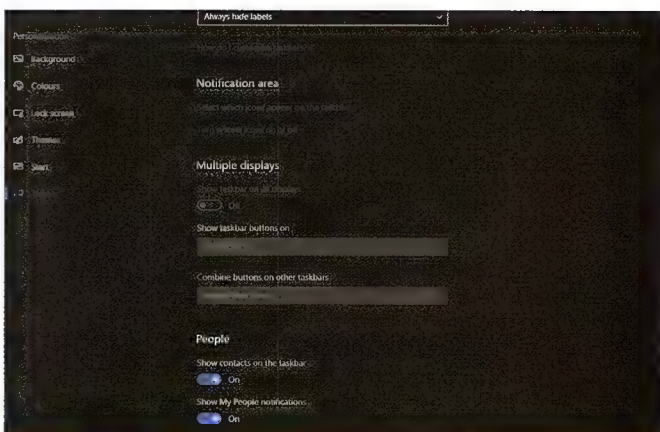
4 GET PINNING

Left-click the My People button at the right of your Taskbar, and you'll see suggestions for who to pin based on how often you contact them. You don't have to accept these suggestions – and as you are limited to three pins, it's worth putting some thought into. To pin a contact, left-click it, and the first three you choose will appear on the Taskbar to the left of the My People button.



6 USE YOUR PINS

Click a pinned contact in your Taskbar, and a pop-up menu appears showing all your recent communications in the accounts you've linked the People app to. The ellipsis (...) top right enables you to launch the People app, unpin the contact or edit it, while the three-line menu (top left) switches between Mail view, or the People view. The pop-up stays open until you close it.



8 SETTINGS

Click the ellipsis at the bottom of the My People pop-up for more options. You can create a new contact, send feedback about the app, and change app settings. In Settings, you can choose whether to turn Taskbar contacts on or off, receive notifications when a new message arrives from a pinned contact, and choose whether that notification plays a sound.

Experiment with Ubuntu Linux inside Windows

Curious about Linux? Neil Mohr shows how you can play with a version of Ubuntu in the comfort of your Windows machine.

No one wants to install a whole operating system, just to mess around with a bit of terminal-based garbage, so Microsoft did the right thing, and brought Linux inside Windows, using the Windows Subsystem for Linux. Partnering with one of the leading Linux developers, Canonical, it developed the WSL to enable you to effectively install the core of the Ubuntu Linux OS inside of Windows. No mess, no fuss, just pure, simple Windows, with added Linux on top... uh, inside.

"Why?" we hear you ask. Because developers love it. It enables them to directly install and run common open-source tools, commands and server services without leaving Windows. It also enables you to monkey around with Linux from the comfort of Windows, without even needing to fire up a virtual machine. So it's free, it's easy to get up and running, won't take up much space, it'll expand your knowledge, and help freak out your friends! What's not to love? Let's give it a try, and explain how you can have some open-source fun along the way.

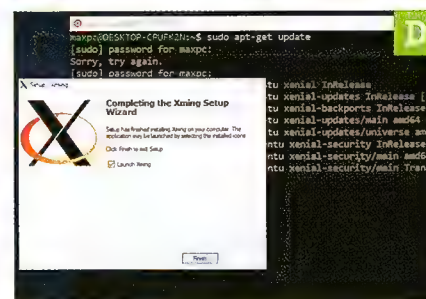
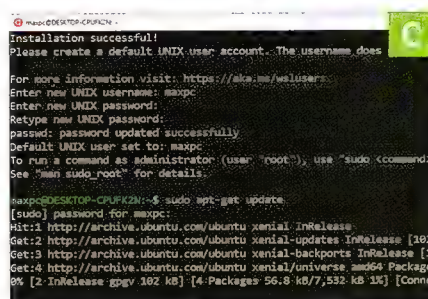
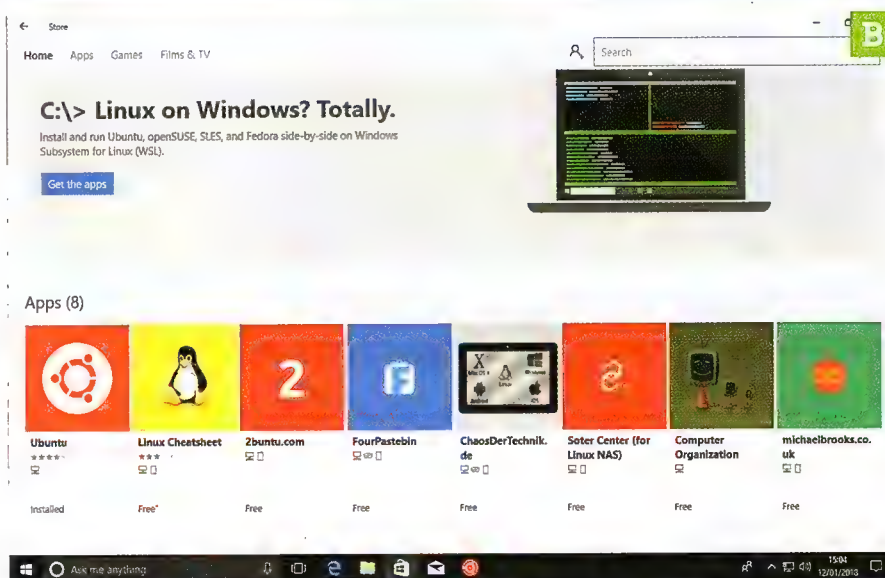
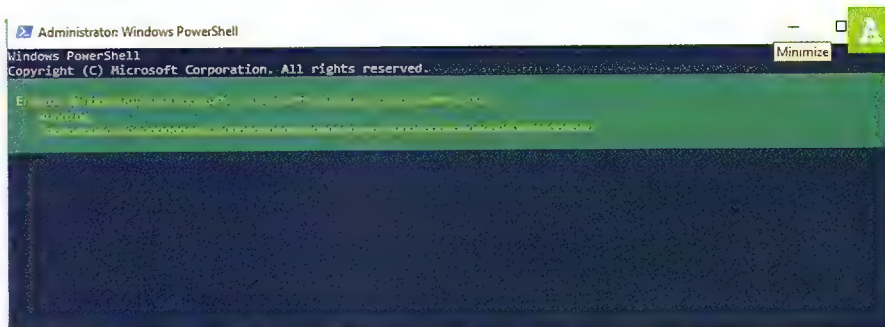
1 PREPARE YOUR PC

Setting up and running the WSL has become somewhat simpler than when it was first introduced back in 2016, as long as your version of Windows 10 has the Fall 2017 Creators Update, which is Windows build 16215 (aka Redstone 3). The most complex step is doing the following: In search, type "powershell," right-click this, and select 'Run as administrator' [Image A]. Enter the following command, and restart your system.

```
Enable-
WindowsOptionalFeature -Online
-FeatureName
Microsoft-Windows-Subsystem-
Linux
```

2 INSTALL LINUX

Head to the Windows Store and search for 'Linux'. Boom — a whole new section dedicated to Linux on Windows. Will wonders never cease? We're only interested in Ubuntu here — OpenSUSE is another major Linux distro, but it uses a different installer system (known as package management)



to Ubuntu. So choose Ubuntu, and click 'Get it' [Image B]. If you run into an error at this point, ensure you ran the PowerShell command, you have a 64-bit CPU, that you have the correct build of Windows 10, and it's installed on the C: drive under 'Default Save Locations' in Settings.

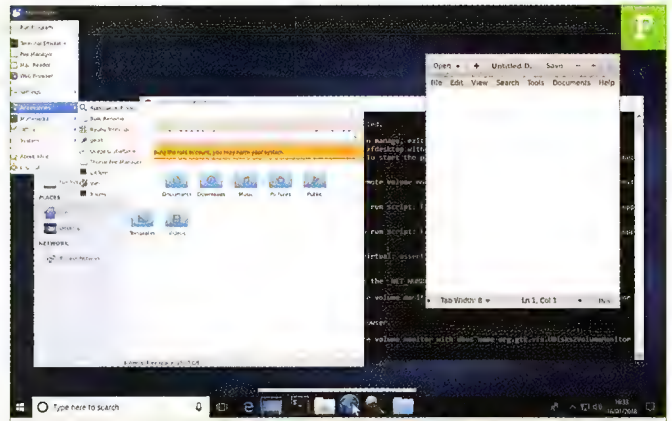
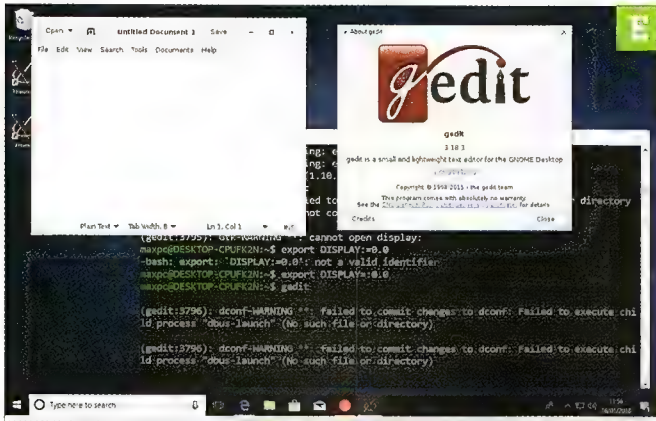
3 SETTING UP LINUX

Before you can do anything, you need to create a user account

for Ubuntu; enter a suitable username and password. Now begin the obscure terminal incantations to start the Linux magic. These first two ensure Ubuntu has the latest packages, and is up to date, so type:

```
sudo apt-get update
sudo apt-get upgrade
```

You'll see a list of scrolling text, which refers to the online repositories where Ubuntu stores OS files, ensuring you have the latest list,



then ensuring Ubuntu has them installed [Image C]. Typically, once it's updated them, it asks you whether it's OK to install the updates.

4 INSTALL A GUI

At this point, all you have is the basic Bash shell – that's the text-based terminal, which is super-powerful, but more for developers and server environments, which we're likely not living with or in. The cool part is that the Linux world uses a graphical system called X to generate its GUI. X uses a server/client model, which means you can access interfaces over network connections or across subsystems. We'll install a Windows-based X server, and the Linux client will be able to launch GUI-based X tools. Download and install Xming [Image D] from sourceforge.net/projects/xming/. Allow the firewall exception as well.

5 TWEAK UBUNTU

That's the Windows side taken care of. On the Linux side – you've run Ubuntu, right? – we need to point any GUI activity at the correct display. Type `export DISPLAY=:0.0`.

- To permanently set this display environmental variable, type: `echo "export DISPLAY=:0.0" >> ~/.bashrc`
- That adds the directive to a script that's run each time you start Ubuntu, technically the Bash shell part. Now we need to install a graphical program: `sudo apt-get install gedit`
- This takes a while. Type `gedit` to run the program [Image E].

6 INSTALL A DESKTOP

If you research this online, you may find references to Dbus fixes; these are no longer required, because it's now part of the default Ubuntu install. This means we're able to dive in and install a Linux desktop – we're opting for a lightweight one called Xfce4. Run each command here in turn: `sudo apt install xfce4` `sudo apt install gnome-themes-standard`

"It's free, it's easy to get up and running, won't take up much space, it'll expand your knowledge, and help freak out your friends! What's not to love?"

`sudo apt install conky`

7 PREP YOUR DESKTOP

We're going to do a bit of housekeeping to keep things neat, so run the command `nano ~/.xinitrc` and, in the text editor, enter the lines of code that follow. When done, press 'Ctrl-O' and hit Return to save it, and 'Ctrl-X' to exit the text editor.

```
#!/usr/bin/env bash
export LANG="en_US.UTF-8"
export LC_ALL="en_US.UTF-8"
exec startxfce4
```

- Run `chmod +x ~/.xinitrc` to make the file we've just created executable, then use `ln -s ~/.xinitrc ~/.xsession` to 'link' that file with another standard X configuration file. Start your newly installed Linux desktop with:

`dbus-launch --exit-with-session ~/.xsession`

- On the first run, a dialog pops up – select to use the default. The Xfce4 desktop appears over the Windows 10 one, so you might want to ensure the Ubuntu window isn't full-screen, because the window bar can be blocked. You should spot an Application menu top-left, there's a dock at the bottom, with a taskbar running along the top. To quit, use the 'Log out' option in the top-left menu [Image F].
- You won't find too much to play with at this point, because it's a Linux desktop running on a largely sparse distro. You can add programs, such as Firefox, via `sudo apt-get install firefox` and this then appears under the 'Internet' menu.

Begone Linux and other tricks

Previously, removing the WSL was a case of running PowerShell as Administrator, and typing `lxrun /uninstall /full`. Now, if Windows 10 is up to date, all you need to do is remove it from the Start menu/Windows Store. By the time we're finishing installing bits, the Linux install will be pushing 1GB, so it's not something you'll want hanging around your C: drive.

We're frankly doing things here with the WSL that it was never designed to do. In fact, trying to get these things working in earlier builds was far more of a bind than they are now. So if you find you're having a few glitches here and there, it's to be expected.

We're going to leave you here, but there's plenty of other things you can do with the WSL. For instance, running `sudo apt-get install compiz-core` and `sudo apt-get install compizconfig-settings-manager` adds a host of visual effects settings that you can monkey around with. You also might notice there's no sound, and while it is possible to add this, it's rather tricky, and probably not worth your hassle. Long story short: Linux uses a server/client sound system called PulseAudio, and you need to install both a Windows version (tricky), and redirect the output to your host Windows machine. Just for the pleasure of likely hearing out-of-sync sound. ■

Speed up macOS High Sierra

Get a snappier, better-performing system with these macOS settings tweaks. Carrie Marshall and Alex Summersby explain how.

Have you updated to High Sierra but found that your Mac now seems sluggish? Or perhaps you haven't taken the step but want to be sure the latest macOS won't slow you down. Either way, there's good news: High Sierra can take a little bedding-in, but it is designed to optimise your Mac's performance, not the opposite, and once you get to grips with it, your Mac could fly.

On older Macs, two changes will make an enormous, life-changing difference: doubling the RAM and replacing the hard disk with an SSD. However, that's not always practical,

affordable, or in some cases even possible – but that doesn't mean you can't speed up your Mac.

The principle is straightforward. The more your Mac is having to do, the slower it'll become. So the trick is to find the things it doesn't need to do and stop it doing them. That might mean removing unnecessary eye candy or apps you don't really need, cutting down on what iCloud does in the background, or making sure your Mac isn't struggling for space.

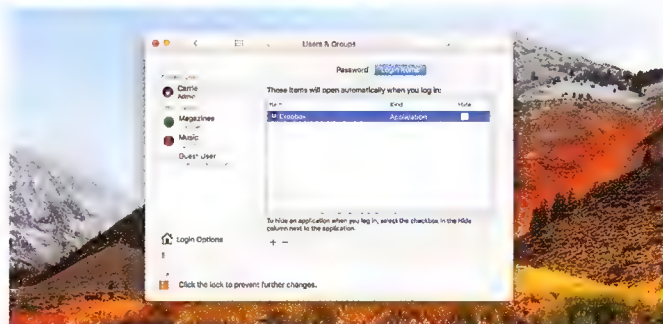
The macOS Activity Monitor, which lives in Applications > Utilities, is handy here. It enables you to see if an app or even a web process has gone

rogue, demanding too much CPU time or memory, and to shut it down. But make sure your Mac isn't the victim of something else. Often, what appears to be a slow app actually turns out to be a slow or flaky data connection.

So here are some tips for identifying what's slowing your Mac and fixing it fast, so you can continue doing what you need to unhindered.

"The more it is having to do, the slower it'll become."

How to: Speed up High Sierra



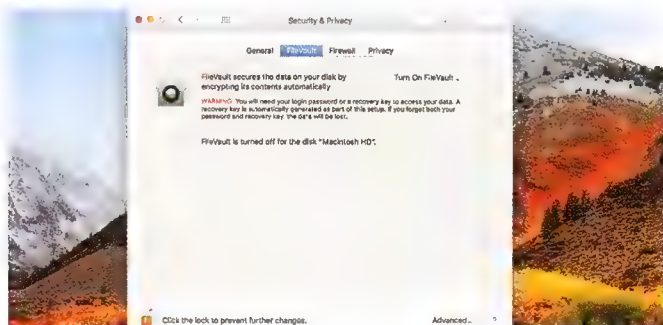
1 FASTER STARTUP

Unneeded apps loading on login will stretch out startup and slow your Mac. Open 'System Preferences > Users & Groups > Login Items', click any app you don't need every time, and click the minus button to stop it loading on login.



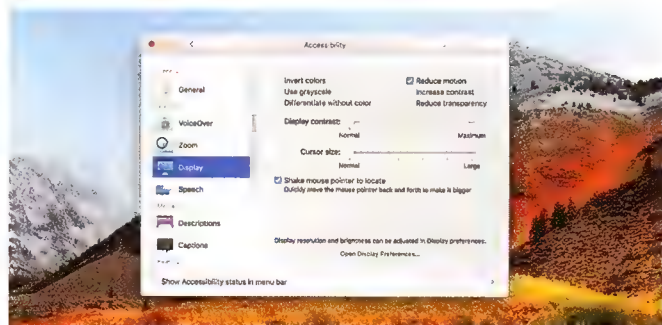
2 LIMIT iCloud

Especially if you have a poor internet connection, backing up to iCloud will slow everything down. If signing out is too extreme, consider opening 'System Preferences > iCloud > iCloud Drive' and turning off 'Desktop and Documents' syncing.



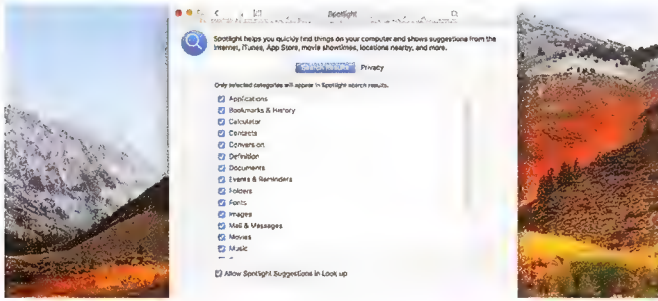
3 DISABLE ENCRYPTION

It's less of an issue on Macs with SSDs, but with a conventional hard disk, there can be a lag as FileVault encrypts or decrypts your files. If you don't need its data security, you can disable it in 'System Preferences > Security & Privacy'.



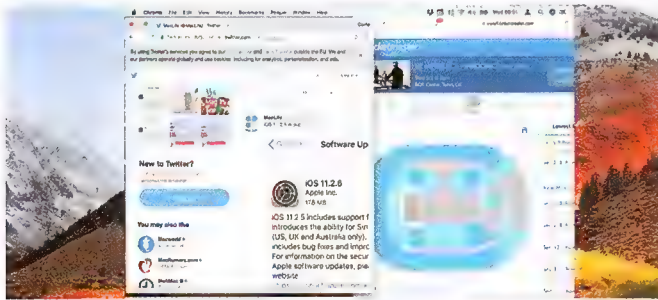
4 ELIMINATE EYE CANDY

If running High Sierra on an older Mac, you can speed up everyday use by disabling unnecessary eye candy such as Finder's visual effects. Reduce motion and disable transparency in 'System Preferences > Accessibility > Display'.



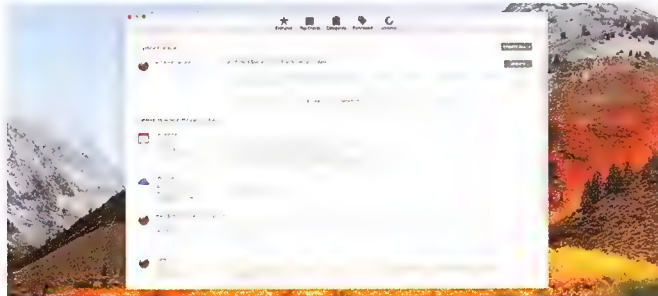
5 STRIP BACK SPOTLIGHT

After any macOS update, Spotlight re-indexes your drives, so things may seem slow afterwards. Leave your Mac on, so Spotlight can carry on when it's idle; filter Spotlight's searching in 'System Preferences > Spotlight'.



7 ONE BROWSER ONLY

Browsers differ — for example, we find Chrome plays better with some web apps than Safari — but browsers are also very demanding on your CPU. Don't keep one running in the background when you're using another.



9 UPDATE YOUR APPS

High Sierra makes some low-level changes to how things operate, and some older apps may not play well with this. If an app freezes on startup or quits for no obvious reason, check 'Software Update' or the developer's website for updates.



11 SPRING CLEAN

We're big fans of housekeeping app OnyX (titanium-software.fr). It sorts small things, such as cache files, that can collectively have a big impact — but make sure you use the right version for the version of macOS you're running.



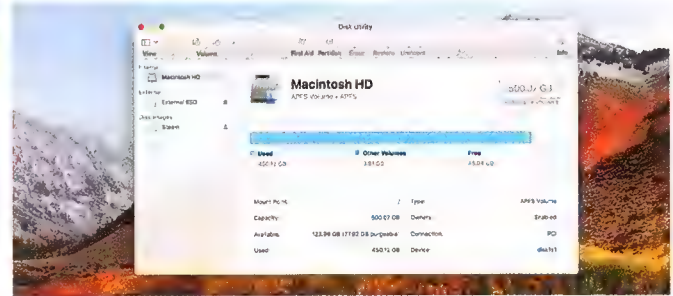
6 BROWSE MORE SIMPLY

The more tabs you have open, the more of a drain your browser is. Plus, a surprising number of slowdowns are caused by buggy website scripts or runaway client-side processes. Quit your browser when you don't need it.



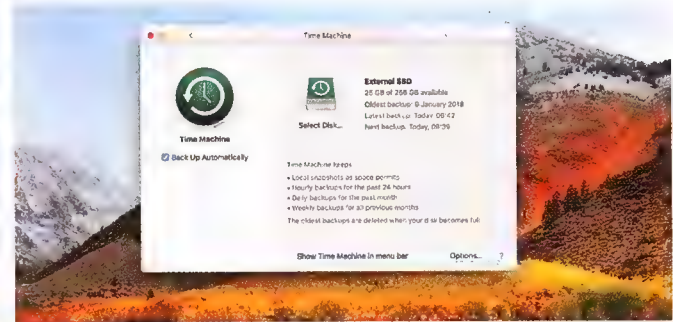
8 REPEL HIJACKS

Safari can be the victim of browser hijacks, which can infect your Mac with unwanted adware and other irritations. The shareware DetectX (sqwarq.com/detectx) does a fine job of finding these, so you can trash them.



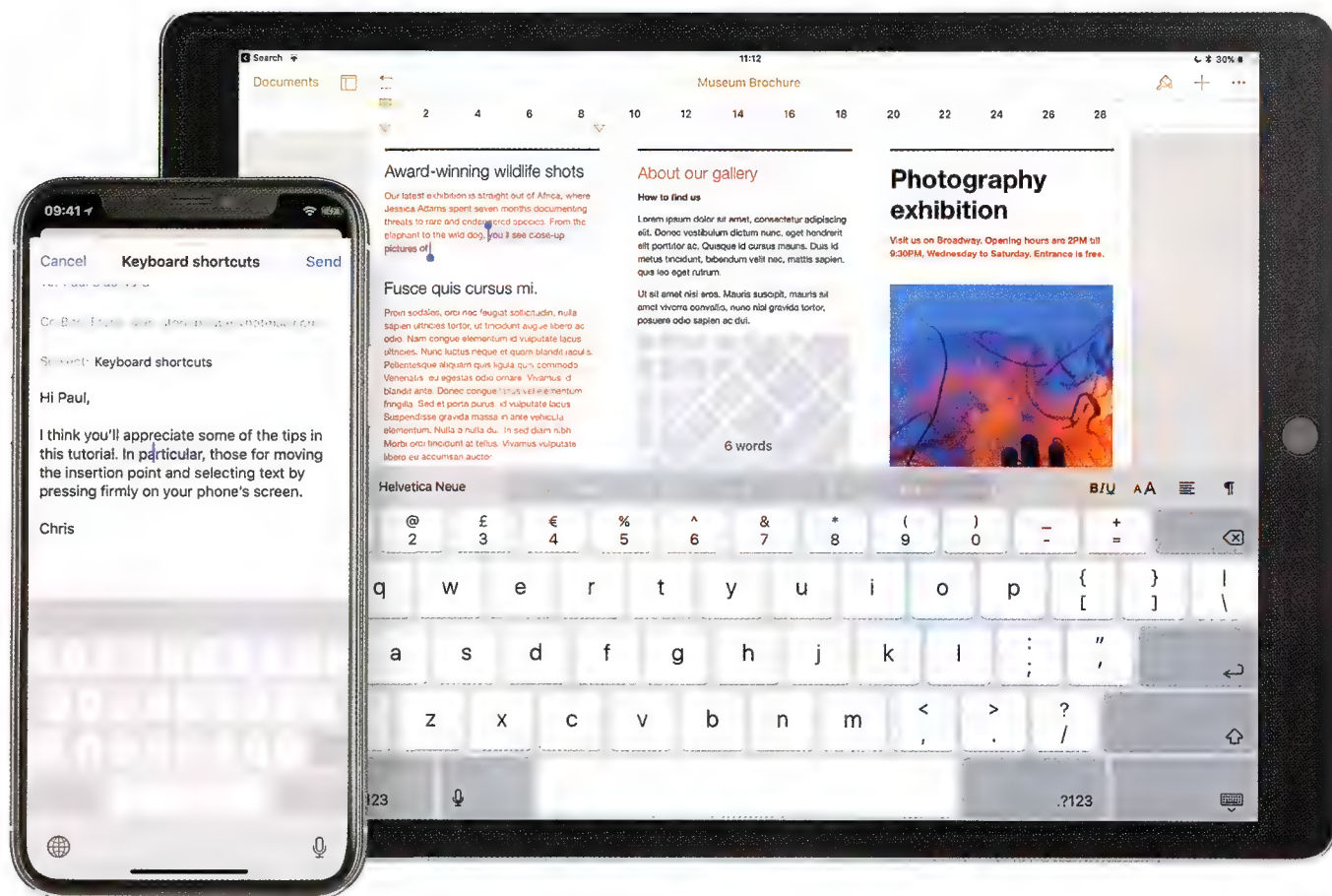
10 CLEAR OUT THE TRASH

High Sierra uses disk space for memory swapping, but if your drive has less than 10% free, that often has a big drag on performance. Empty that trash, declutter Documents, and archive stuff you're not using to an external drive.



12 START FROM SCRATCH

Ensure you have a reliable, up-to-date backup. Erase your drive, reinstall High Sierra, and restore your files from your backup. This should cull any corrupted preferences and defragment your data, speeding up non-SSD drives. ■



Uncover iOS's hidden speed-typing tools

Christopher Phin reveals the productivity-boosting tricks concealed under your keyboard.

You might think that to get any serious typing done on an iPhone or iPad you need to use an external keyboard.

While it's true that you can do that — over Bluetooth, using a Smart Keyboard, or using Apple's Lightning to USB adapter — if you learn the little tips and tricks Apple has baked into the on-screen keyboard, everything from a tweet to the next great novel is well within the reach of your fingertips. Let's get typing!

We'll start with something fundamental. Most people will only really use one keyboard for typing, but you can set up several. One main use for this is for typing in different languages; adding other keyboards in Settings > General > Keyboard > Keyboards doesn't just change the layout of the keys to match conventions in that country (AZERTY

rather than QWERTY in France, for example), or even the input method entirely, but it changes the autocorrect dictionary, too. (Here's a really hidden feature: you can override the keyboard layout change — to retain the benefits of the autocorrect change without the confusion of letters moving around — by tapping the name of the keyboard you've added in this list.)

If you do type in more than one language, therefore, and have been cursing autocorrect for mangling your words, here's the solution, and it even works for different versions of English; handy if you sometimes need to 'humor' our 'neighbors' in America without causing 'offense'.

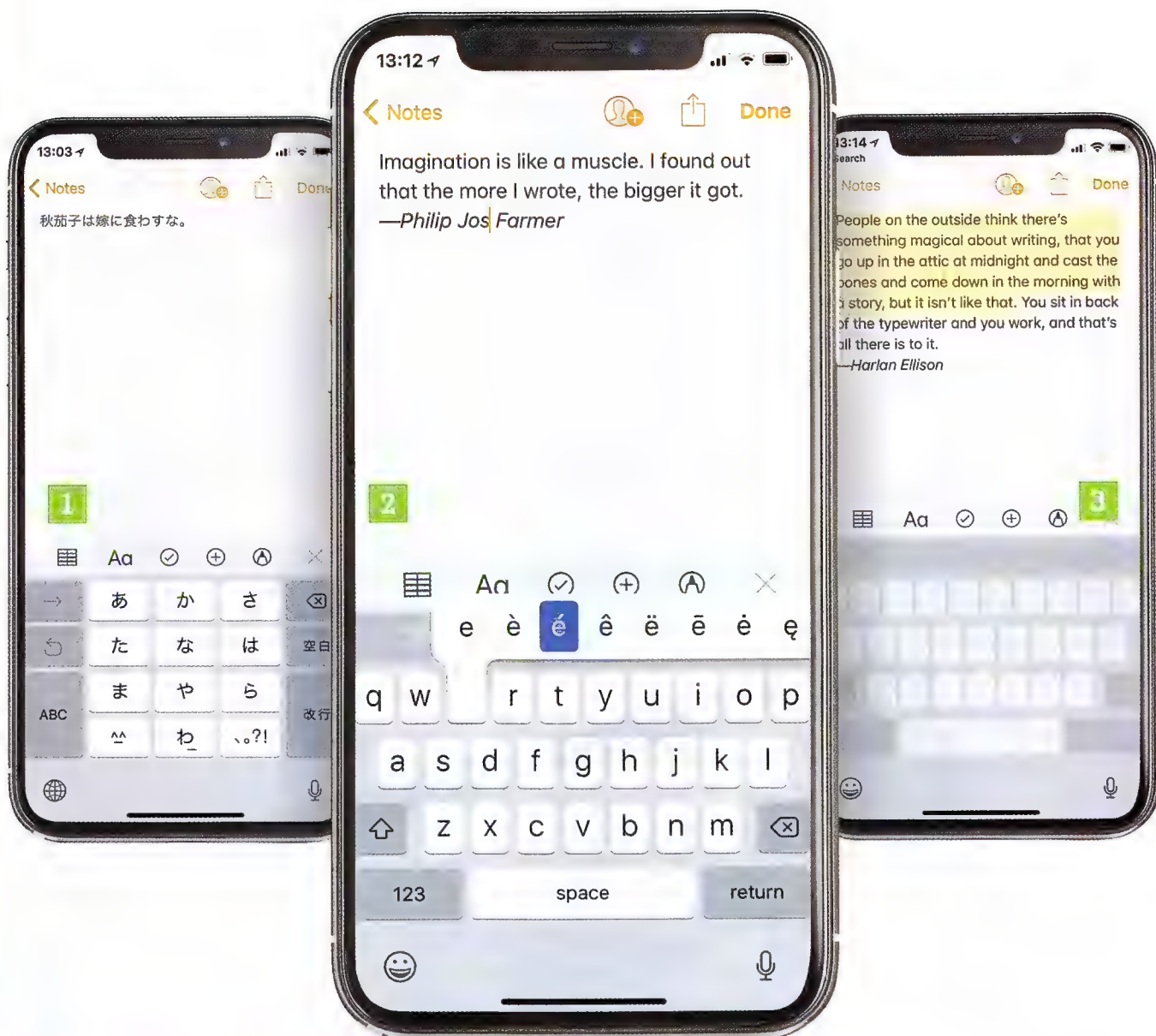
I To switch between the keyboards you add (in the order you set them in Settings > General > Keyboard

> Keyboards), tap the globe icon at the bottom left of the keyboard. If you only have one main keyboard installed, this will instead be a smiley face, as it toggles to the emoji keyboard.

EMOJI AND SPECIAL CHARACTERS

So long as you have the Predictive bar turned on, though, it can act like emoji search, and you don't even have to switch to that keyboard; type 'chips', say, and the last option in the predictive bar is the French fries emoji. Tap it to replace the word with the emoji. (Even this is localised, delightfully; this particular example doesn't work with the US English keyboard, since 'chips' are crisps in America!)

You might be used to tapping '123' to switch to the numbers, but if you only need to type a single character from this keyboard, it can be more



"Most people will only really use one keyboard for typing, but you can set up several."

efficient just to drag your finger from the '123' to the desired number key — the keyboard will temporarily switch layout in between — then release to get back to the usual keyboard.

If you're on any iPad except the 12.9-inch (and only then when using optimised apps), you also see secondary characters on the keys; just flick down on the key to type them.

2 Hold a finger on a key to see alternate characters, and voilà — you can type 'voilà'! It works for less well-known things, too; hold on the \$ sign, for example, and you get other currency symbols, or on the full stop when entering a web address in Safari

to see other domains, such as .com.au, .com and more.

MOVE THE INSERTION POINT

The traditional way to move the insertion point, or caret, around on iOS is to hold a finger on the text you were writing, and then use the magnifying glass pop-up to get it into the right place. That's a little fiddly and prone to error around the edges of the screen, and there is a better way on iPad, and iPhones with 3D Touch.

On an iPad, you can just slide two fingers around the keyboard to move the caret, and on an iPhone with 3D Touch, just press firmly on the keyboard with one finger to switch to this mode, then slide your finger

around. Once you've moved the caret to where you want it on iPad, lift your two fingers, set them down again, wait a beat, then move; you'll then be selecting text.

On iPhones equipped with 3D Touch — the pressure-sensitive display technology that was introduced on the iPhone 6s — you have extra options for text selection, though they take some trial and error to learn. Once you've pressed firmly on the screen to move the caret, you can reposition the caret over a word and then press even harder

Quick tips

Made a mistake? You needn't reach for the Undo button to roll back your text; just shake your device, provided 'Settings > General > Accessibility > Shake to Undo' is switched on.

to select just that word. That bit's easy enough, but with practice you can also double-press to select the whole sentence at once, or triple-press to select the whole paragraph.

3 You can combine the two-finger and 3D Touch shortcuts with dragging. Let's say you have a three-sentence paragraph and want to copy only the first two sentences; press firmly to start moving the caret, position it anywhere over the first sentence, double-press to select that sentence, then drag to the second, which will be selected in its entirety – though the paragraph's final sentence will be left out.

In either scenario, you can grab the little handles that appear at each end of your selected text to fine-tune what

you're picking up, if necessary, and you can also tap either of these handles to bring up the options bar, with cut, copy, paste and other options, if they aren't already visible.

CAPITALS AND SPECIAL CHARACTERS

Let's go back to something easier: switching to capital letters. This can be as simple as tapping the Shift key to switch only the very next character you type to uppercase, or double-tapping it to turn on Caps Lock. Note that you can use the same slide technique we mentioned for the '123' keyboard switch; slide from the Shift key to a letter and it will be capitalised without the need to dismiss the caps keyboard afterwards. iOS will try to be helpful in capitalising new

"You can combine the two-finger and 3D Touch shortcuts with dragging."

Accessibility 3D Touch

3D Touch

When 3D Touch is on, you can press on the display using different degrees of pressure to reveal content previews, actions and contextual menus.

3D TOUCH SENSITIVITY

Light Medium Firm

Adjust the amount of pressure needed to activate 3D Touch. Light sensitivity reduces the amount of pressure required; Firm sensitivity increases it.

3D TOUCH SENSITIVITY TEST



In iOS's Accessibility settings are helpful options to alter the sensitivity of the keyboard and 3D Touch.



Splitting the keyboard makes typing easier when holding your iPad, at least on smaller models.

Quick tips

If you use multiple email addresses, text replacements can work out quicker for typing them than relying on the keyboard's QuickType suggestions bar. For example, you might use `@ic1` to type your iCloud address, `@gma` for Gmail and `@1st` for an alias you use for newsletters and other mailing lists.

sentences, but if you don't like this, you can turn off Auto-Capitalisation in 'Settings > General > Keyboard'. Here, you'll also see a toggle for the full stop shortcut; in case you aren't familiar, that enables you to double-tap the space bar to get a full stop, a space, and the next letter capitalised.

We mentioned holding a finger on some keys to get accented forms and alternative characters. On some iPads running iOS 11, keys may display a second character. Rather than using Shift or holding the key, flick upwards from the key to type the second character more quickly. (Settings > General > Keyboards > Enable Key Flicks must be switched on.)

KEYBOARD SIZE AND POSITION

There are a couple of things you can do to change the size and position of the keyboard.

4 On an iPad, either drag the left and right of the keyboard apart with your fingers, or hold a finger on the keyboard icon (bottom right) and tap Split in the menu that appears; this separates the keyboard at the sides of the screen so it's easier to type with your thumbs when holding your iPad. Adjust their vertical position by dragging the icon at its bottom right. Drag all the way to the bottom to return to a single, large keyboard.

5 On an iPhone running iOS 11, except for the 5s and SE, you can make the keyboard easier to use one-handed by holding on the emoji/globe icon (bottom left) and choosing to shunt the keyboard over to the left or right side of the screen. The keys become narrower, like on pre-iPhone 6 devices, but are easier to reach with your thumb.

Don't feel this has to be a permanent decision; it makes sense to toggle it when you're trying to type while walking, say, even moving from right to left as you swap hands, but then switching back to the full-width keyboard once you get where you're



going; tap the large arrow next to the keyboard.

SPEED UP YOUR TYPING

As well as all this, iOS provides some very helpful ways to speed up what you type. Text replacement is a great one, with three common applications. First, to replace clusters of characters with short phrases (such as typing `omw` being replaced with 'On my way!'), and even 'correcting' weird iOS auto-corrections. Second, to type characters that would otherwise require laborious searching/copying/pasting – to have `cp rt` become `@, say`.

The third major use is to type phrases or longer passages of text that you write often. For example, you might type `reply?` and have iOS replace that with a couple of paragraphs of text that are your standard response to a question you're frequently asked by email. Or, if you often search Apple Support articles in Safari, set up a shortcut to replace `#spt` with 'site:support.apple.com' so that you only get Google search results from that part of Apple's site. Set up text replacements in 'Settings > General > Keyboard > Text Replacement' on iOS, or in `Apple > System Preferences`

Keyboard > Text' on a Mac. Whichever device you do this on, your text replacements will sync to your other Macs and iOS devices signed in to the same iCloud account.

SAY YOUR WORDS

6 Finally, don't forget about dictation, which you'll find at the bottom of 'Settings > General > Keyboards'. It works for English even when your device is offline, and though you might feel weird doing it in a shared office or classroom, these days it's highly accurate – and usually much faster than typing, if you can think and talk in complete sentences. You can even dictate punctuation and issue 'commands', such as 'full stop' and 'new line'. ■

Quick tips

If you find 3D Touch's sensitivity a little 'off', adjust it to require a lighter or firmer press in 'Settings > General > Accessibility > 3D Touch'.

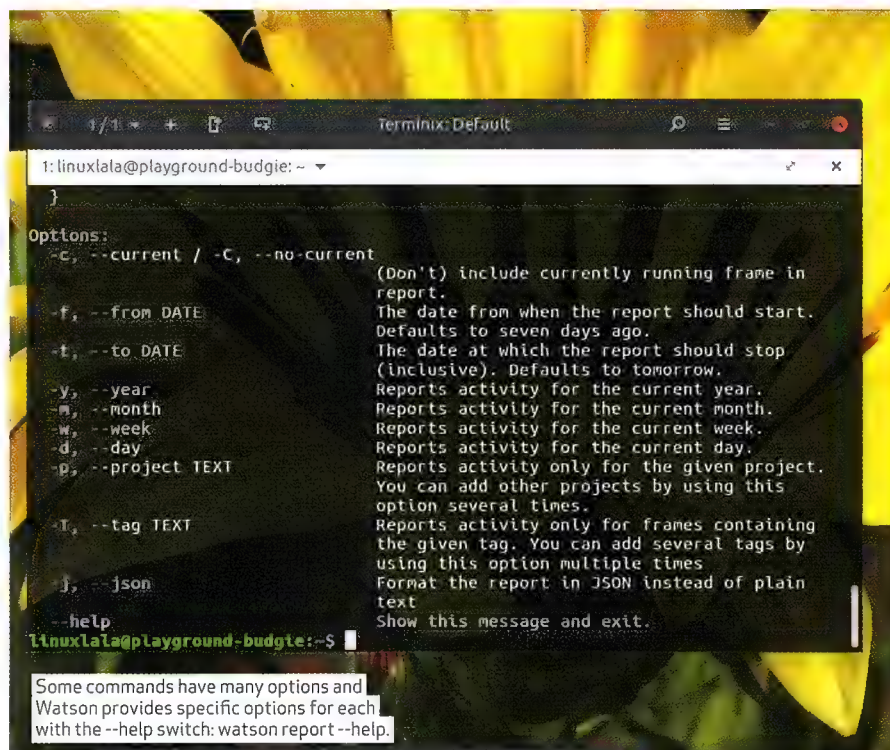
Track your time via the Linux terminal

Keeping track of the time you spend on a project may seem like a Herculean task in itself. Thankfully, Shashank Sharma has a quick and easy solution.

Unless you're very, very organised, you're unlikely to be able to accurately describe the amount of time you spend on any given task performed over any given period. Keeping careful track of the amount of time spent on a task becomes a priority if you plan to bill clients on an hourly basis.

A time-tracking app can be used to help make sense of how you spend the hours at work. This data can help you identify areas where you need to increase your productivity. You might realise you're taking rather long lunches or spending too much time on research, and not enough responding to emails (although, of course, we all know that some emails can be safely ignored [*Careful now... — Ed*] or better still, deleted immediately).

Watson is a command-line utility written in Python and released under the MIT License. It enables you to easily track the time spent on projects and assignments. It can then generate reports on the collected data and



Configuration options

A time tracker is a multi-tasker's worst enemy. This is because tools like Watson is unable to record activities across different projects at the same time. Of course, you can use multiple tags with a single `watson start` command, but unfortunately you can't record two projects simultaneously.

You must always remember to stop timing a project with the `watson stop` command. Alternatively, you can configure Watson to stop recording the current project when you give a fresh `watson start` command.

There are two ways to do this. First, you can run the `watson config options.stop_on_start TRUE` command. Alternatively, you can run the `watson config -e` command, which opens the configuration file in the configured editor, and you can add the following lines into it:

```
[[options]]
stop_on_start = TRUE
```

When changing the configuration option from the terminal, the format of the command is `options.name_of_option VALUE`. The value can be either `TRUE`, `FALSE`, `1` or `0`. The same options when defined in the configuration file with the `watson config -e` command, have to be placed under a `[[options]]` heading as demonstrated in the code block.

The user guide on the official Watson website describes a few other configurable options, such as for the time and date format, and whether the tool should generate report for the current project, or all projects that you're currently involved in.

reveal how you spent the work hours on any given day, week, month or even an year.

ELEMENTARY DEAR READER

The project is hosted on GitHub and you can easily clone the repository and install Watson. For most distributions, an easier installation option is to use the pip package manager. If you don't already have it installed, you can run the `sudo apt install pip` or `su -c 'dnf install pip'` command on your Ubuntu and Fedora machines. Most other distributions also provide pip in their repositories and you can install it without hassles. You can then install Watson with

```
sudo pip install td-watson .
This will automatically fetch and install the tool in the './.local/bin' directory. Because this directory isn't described in $PATH, you can't use Watson just yet. Run the echo 'export PATH="$HOME/.local/bin:$PATH"' >> ~/.bashrc
```


command, which adds this path to your `.bashrc` file. You must now reload the `.bashrc` file with the `source .bashrc` command.

One of the best features of Bash is its tab-completion and you can configure Watson for tab-completion by downloading the `watson.completion` file from the GitHub repository and placing it in the `/etc/bash.completion.d/` directory. When you restart the shell terminal, you'll be able to use tab-completion with Watson. To begin, type `watson [tab] [tab]` in the terminal for a list of all available commands.

For each task you wish to record with Watson, you must specify a project name and you can have several different tasks within each project. For instance, a project named `Leisure` can be used to track the amount of time you spend on non-work activities. Here, reading and video games are tasks within the project. These tasks within a project are referred to as tags. You can use the same tags across different projects.

Every time you run the `watson start` command, the project records all the relevant data such as the name of the project, the relevant tags and the start time and stores it in what the project refers to as frames.

When you run the `watson stop` command, the project stops recording and prints out the frame id for the last recorded session. You can get a list of all the recorded frames by running the `watson frames` command. The name of the frame itself doesn't reveal any information about the data it contains, such as the project name or the start and stop times.

GETTING STARTED

Before you can begin generating reports of how you spend your work hours, you must first identify the different projects and tasks you wish to record with Watson. Then you can start recording a session with the `watson start projectname +tags`. Each start command supports the use of several tags:

```
# watson start Leisure
+reading
Starting project Leisure
[reading] at 19:53
```

The first command tells Watson to record a project named `Leisure`. The use of `+tags` is optional, but we've used it here to identify the type of leisure activity. Watson will provide the name of the frame for the most recently recorded activity when you run the stop command:

```
# watson stop
Stopping project Leisure
[reading], started 12 minutes
ago. (id: c382b0b)
```

Watson uses a new frame for every new start command, even if you restart an already existing project. You can use multiple tags with the start command, or use different tags for the same project at a later time, like using the `+Coffee` and `+Lunch` tags at different time to record the Breaks you take during the day:

```
# watson start Break +lunch
Starting project Break
[Lunch] at 13:15
# watson stop
Stopping project Break
[Lunch], started 30 minutes
ago. (id: 0d8583d)
# watson start Break
+"evening tea"
Starting project Break
[evening tea] at 19:25
```

As you can see, we've used the `Break` project but with different tags each time. You can run the `watson frames` and the `watson projects` commands to respectively fetch a list of all the frames and projects. Don't worry about several frames existing for the same project and tags. When generating reports, Watson will automatically add the amount of time spent on any project or task across different frames.

REPORTING FOR DAILY

You can use Watson to generate daily, weekly or monthly reports. If you want reports for a specific project only, or for a specific period, like say 50 days, you can do that as well. The `watson report` command will display all the project's details:

```
# watson report
Thu 15 February 2018 -> Thu
22 February 2018
Break - 2h 23m 34s
[evening tea 2h 23m 34s]
Doctor's-Visit - 2h 21m 11s
APC452 - 30h 04m 08s
[Roundup 17h 01m 37s]
[Tutorial 13h 02m 31s]
Leisure - 1h 04m 11s
[comics 02m 32s]
[reading 1h 04m 11s]
Lunch - 1h 20m 48s
[break 1h 20m 48s]
Total: 36h 22m 38s
```

If looking at the above data makes you question our evening tea habits, don't! By default, Watson provides the data for the past seven days. The block here is for the period between 15 and 22 February. As you can see, it shows a lunch of only one hour 20 minutes, which means we forgot to record the lunch on more than one occasion during the week.

Should you wish to edit a frame, such as when you continued working on a project after stopping Watson, you can run the `watson edit frameid` command, which opens the relevant frame in the configured text editor, and you can then change the stop/start times. You can also rename a project or tag with the `watson rename` command.

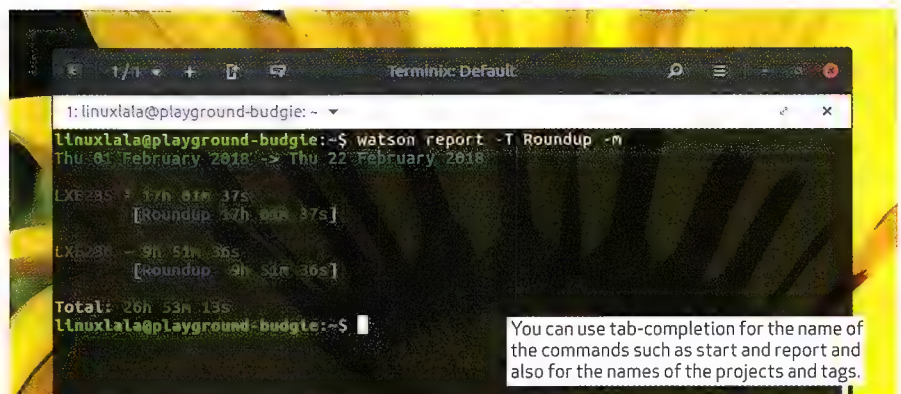
You can run the `watson report -m` command for a list of all the projects you worked on in the current month. You can similarly generate reports for a specific tag or project using the `-T` or the `-p` options with reports:

```
# watson report -T Roundup
-m
Thu 01 February 2018 -> Thu
22 February 2018
APC453 - 17h 01m 37s
[Roundup 17h 01m 37s]
APC454 - 9h 51m 36s
[Roundup 9h 51m 36s]
Total: 26h 53m 13s
```

Here, we've combined switches to generate reports on a tag for the current month. Since we used the same tag across different projects, Watson automatically reports the data for both projects.

Watson doesn't identify frames using the project name, so you must run the `watson log` command for a list of all the Watson commands you've run. This will provide you a date list of all the frames (latest first), and the corresponding project/tag name, etc.

It's easy to see the appeal for a project like Watson, even if you're not required to keep time sheets. You might even be surprised at what it has to report at the end of the working week. Now, about those emails... ■





AMD sub-\$800 budget build

Alan Dexter reveals how Ryzen APUs are bringing bucketloads of bounty to the budget builder's back pocket.

THE CONCEPT

The idea behind our budget builds is simple enough – construct the most affordable machine possible for the smallest pile of cash. We're not utter masochists, though, so while it is possible to build a machine even cheaper than we have here, there are some quality-of-life choices that we see as a bare minimum. We won't, for instance, touch non-brand hardware, because we've been down that road before, and in our experience, such corner-cutting never ends well, especially when it comes to cases and power supplies. But it does mean that

even before we start, there are potentially further savings to be made. But we're getting ahead of ourselves here; let's get back to the concept.

What makes this budget build possible is AMD's new Raven Ridge APUs, specifically the Ryzen 3 2200G. Here is an APU that packs a semi-decent graphics processing unit alongside a quad-core chip for just \$139. That it also happens to net you a decent little air cooler as well is more reason to be impressed by the value for money. It doesn't take much more hardware to turn that most budget of AMD chips into a useful system.

So, what can you do with a modern AMD APU? Pretty much anything you want, bar high-end gaming. It'll handle older games with only the subtlest of tweaking, and even give newer games a good try. Those four cores mean it can handle processor-intensive tasks well enough, but if you're looking for workstation levels of performance from a budget chip, we've got some bad news: you still get what you pay for, and for serious power, you're going to have to eye up the higher echelons of the Ryzen stack (and cough up for a graphics card).

BUILDING TO A TIGHT BUDGET

With the processor selected, the rest of the component selection is simply a case of assembling budget-conscious hardware to make our chip of choice truly shine. The main component to focus on here is the RAM, because Ryzen APUs love a high-speed memory bus. Not only does the CPU get more bandwidth to play with, but the graphics side of things can strut its stuff so much faster because of it. This is why we grabbed the 8GB kit of Corsair Vengeance LPX DDR4-3000 memory, which just so happens to be the most expensive component in this whole build. Yup, more expensive than the processor itself.

You obviously also need a decent motherboard to make the most of these two, and here we reached for MSI's value-tastic MSI B350 PC Mate. For a budget board, it manages to pack in a lot of great features, including isolated audio circuitry, with separate layers for left and right channels, USB 3.1 Type-C, and support for M.2 drives at up to 32GB/s. Not that our budget extends to an M.2 drive, but the option is there. Which brings us nicely to the storage side of things: we've elected to use the same storage for the Intel and AMD builds, which is made up of a 120GB Kingston SSDNow UV400 and a 1TB Western Digital Caviar Blue drive, giving plenty of storage for applications and data, as well as speedy storage for the operating system.

That leaves the last two components of our build: the chassis and the power supply. Zak was suitably impressed with the budget-conscious MasterBox Lite 5 from Cooler Master (see the full review on page 28), and while it's not the cheapest box you can throw your machine in, it has plenty of great features that make building in it a good experience. The Corsair power supply, meanwhile, offers great value for money, at just \$69 for this 450W model.

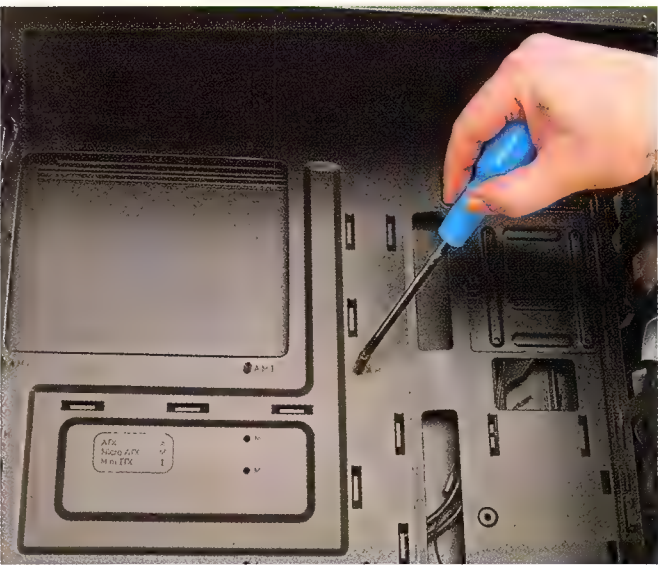
PARTS LIST		
PART		STREET PRICE
CASE	COOLER MASTER MASTERBOX LITE 5 RGB	\$99
MOTHERBOARD	MSI B350 PC MATE	\$139
CPU	AMD RYZEN 3 2200G	\$139
MEMORY	8GB (2 X 4GB) CORSAIR VENGEANCE DDR4-3000	\$175
PSU	CORSAIR CX 450W	\$69
STORAGE 1	KINGSTON SSDNOW UV400 120GB	\$65
STORAGE 2	WESTERN DIGITAL CAVIAR BLUE 1TB	\$69
TOTAL		\$755

"The main component to focus on here is the RAM, because Ryzen APUs love a high-speed memory bus."



1 TESTING TIMES

Different builders go about making sure their hardware works in different ways, but we're fans of ensuring the core components work fine outside of the case. We do this by plugging the RAM, CPU, and cooler in place before attaching the power supply and shorting the power pins to make sure it boots up. Attach a monitor to the video out, and you should find yourself looking at the BIOS screen. You'll need to attach your keyboard and mouse if you want to make any changes, and now is also a good chance to update the BIOS — which we did here by downloading the update on another machine, before transferring it on to a USB stick, and updating from there.



2 MULTIPLE STAND-OFFS

The Cooler Master MasterBox Lite 5 RGB supports both ATX and ITX builds, and as such only has two motherboard stand-offs installed by default. Our MSI motherboard is a full ATX design, which means you'll need to screw the other seven stand-offs into place if you want your motherboard to be secure and fit for moving around. Cooler Master includes a small adapter in the box to make screwing these stand-offs into place easy using a standard Phillips screwdriver. The positioning of these is clearly marked on the motherboard tray, although it's worth checking that your motherboard lines up properly with them if you've selected a different motherboard.



3 DROPPING IN

Disconnect the power supply from the out-of-box-testing setup from step one, then ease the motherboard into place so that it sits on top of the stand-offs you've just attached. Don't forget to pop in the rear I/O plate beforehand, though — it clicks neatly into place when it's properly inserted. You need to angle the motherboard so that it connects with this. Once done, it's simply a case of screwing the motherboard into place using the supplied screws. It's worth making sure that the case's front panel connector cables don't get trapped under the motherboard as you're doing this.



5 DRIVE TIME

Before we start connecting those power supply cables, now is a good time to work out where your drives are going to go. The MasterBox Lite 5 has room for a pair of 3.5-inch hard drives at the back of the machine, and the brackets for housing these are easy to use. When it comes to the SSD boot drive, there are plenty of mounting options. You start by securing the drive to the mounting bracket, then clipping it in place wherever you deem is best. Here we've decided to place it above the power supply, where it'll be on show through the case's window. Secure it with the thumbscrew, and you're good to go.



4 POWERING UP

Despite being a budget case, the Cooler Master chassis has some neat touches, including a mounting bracket for the power supply, which makes installing your PSU that much easier. Essentially, you release the bracket from the back of the case using the pair of thumbscrews, screw this plate on to the back of your power supply (making sure to get the orientation right, so that the PSU fan is pointing downward), and then slide it into place. Because this is a non-modular supply, you'll want to bundle up the cables, thread them into the machine, and make sure they aren't catching on anything first. Finish by securing the PSU using the thumbscrews on the plate.



6 CABLE GUY

All the components are now in place, so it's time to start connecting everything up. There's plenty of room in this case to route your cables, and even attaching the often-tricky eight-pin CPU cable isn't too difficult. Simply thread it out of the back of the machine, and route it up behind the motherboard tray, before threading it back through the top corner. You can then clip the cable in place before taking up the slack and securing it in the PSU bay. The other cables are straightforward to connect, and don't forget the front panel connectors, or the case's four fans. You can hold cables in place using the wealth of cable ties that come with the case as well.



- 1 The Wraith Stealth Cooler that comes with the chip does a great job of cooling the Ryzen 3 2200G while keeping the noise levels down. Mounting it is easy enough, too.
- 2 The Corsair Vengeance DDR4 RAM may be rated at 3,000MT/s, but the fastest XMP profile tops out at 2,933MT/s. Still plenty fast enough for our Ryzen to strut its stuff.
- 3 There's plenty of upgrade potential on offer with this build, with room for a speedy M.2 drive, plus plenty of slots for a graphics card and any expansions you want to add.
- 4 The mounting system for the SSD enables you to quickly and easily position it in the perfect place for your build. There are two slot locations on top of the PSU divider, and another two to the right of the motherboard.

Budget brilliance

As far as builds go, this was reassuringly smooth. There were no horrible surprises and, aside from one small mishap with the internal USB 3.1 cable (we'll come to this shortly), it probably goes down as one of the easiest builds we've ever undertaken. Checking that all the components were working outside of the case before we started the main build meant that we had the peace of mind of knowing that we didn't have to strip it all back again in case something went wrong.

One thing to watch out for when you're building a Ryzen 3 2200G or Ryzen 5 2400G machine is that you need to use a motherboard that has

an up-to-date BIOS, so the graphics output will work straight from the box. If you are using an older motherboard, you need to flash the BIOS first using another chip. We had a Ryzen 7 1800X and a GeForce 1080 Ti on hand just in case, but in the end, didn't need them. We did need to flash the BIOS to get the most from the RAM, though, because prior to updating it we couldn't get it to boot with either XMP profile.

We have to applaud Cooler Master for the case – it boasts a number of features that made this build smoother than it otherwise would have been. The separate section for

the power supply, the hard drive caddies and SSD mounting plate, and great open-plan design meant that we weren't trying to work in tiny, cramped sections, as we sometimes do. One thing of note is that we couldn't get the fans to light up with this motherboard, despite the fact that it had an LED header. They do their main job fine, just without a light show.

As for the USB 3.1 cable problem, this was actually down to how we photographed the machine and wrote these articles. Basically, it means that the machine is built and stripped down several times in the process. And in one strip-down, we were a bit too giddy with the internal USB cable, and managed to break the house of the socket as we unplugged it. A touch of glue fixed this quickly enough, but it's still worth being careful around those right-angle mounted brackets.

In performance terms, there's a lot of bang for your buck with AMD's new chips, and while the frame rates are low in our games, it's worth noting that these tests are carried out at the highest 'Ultra' settings, and playable frame rates are possible at lower settings. Overall, we've been impressed by how easy it is to put this system together and how well it performs. Despite everything, it's still a great time to put a budget AMD rig together. 

BENCHMARK RESULTS

	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	1,152	563 (-51%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,400	524 (-85%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,720	382 (-78%)
RISE OF THE TOMB RAIDER (AVG FPS)	60	12 (-80%)
TOTAL WAR: WARHAMMER II (AVG FPS)	46	9 (-80%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	39	9 (-77%)
3DMARK: FIRE STRIKE (INDEX)	11,101	2,598 (-77%)

Our APC Labs Test PC consists of an AMD Ryzen 5 1600 @ 3.2GHz, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.



Intel sub-\$800 budget build

Facing up to its AMD competitor is Zak Storey's lean, mean, not green, slightly OK office machine.

THE CONCEPT

These builds have been an interesting exercise in budgeting, that's for sure. We often work at the crazy end of the system-building spectrum here in the labs, and as we've mentioned in the past, it's far easier to get expensive components in than more affordable gear. Which, although truly hysteria-inducing at times, makes working on a project like this far more satisfying.

That said, this isn't the first time we've looked at such affordable rigs. Back at the start of 2017, you could just about build an Intel rig on a \$600

budget with 8GB of DDR3 and a 256GB SSD... and a terrible, terrible, terrible processor. No, seriously, just how far things have come in processing performance in the last year is staggering. But more on that later.

So, what was the idea behind these two projects? In short, to keep things simple. Build two systems with a suitable upgrade path, and plenty of grunt to drive some modern 1080p titles, at medium settings or so. And to do it without breaking the bank. As memory and GPU prices have skyrocketed over the last two years,

the game has changed significantly when it comes to pricing up rigs like this, and that \$600 budget that you could have strived for 18 months ago is — today at least — a complete non-starter.

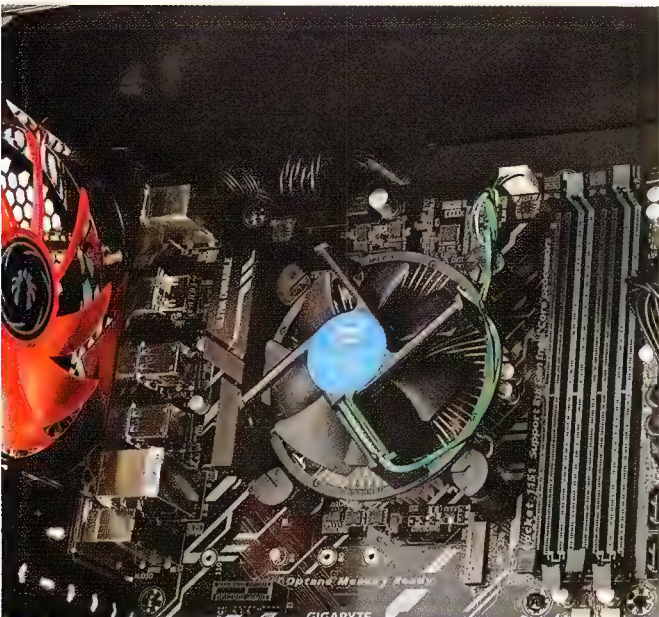
Admittedly, we haven't included the price of the OS with these machines, because we're focusing more on the hardware, but you can pick up Linux for free, and an OEM copy of Windows 10 is pretty cheap nowadays. Anyway, now the waffle is out of the way, let's break down just what went into this very special Intel build.

THE BUDGET BUSTER

Let's be frank, there's not a huge amount of difference between our two builds. Spec for spec, they're both fitted out with a similarly priced processor, similar memory, and like-for-like storage. Yet it's the small details, the less-performance-affecting choices we've made, that really separate the two systems.

The most obvious being the two cases. Going up against the AMD build's Cooler Master MasterBox Lite was always going to be a challenge. With its absolutely absurd arsenal of modern-day features, including three RGB front fans, coloured accents, tempered glass and stellar internal layout, we needed something that could give it a fair run for its money. The BitFenix Nova TG brings that fight down hard. Coming in at a street price of \$74, it's 20 bucks cheaper than its competitor. Featuring an old-school internal layout, tons of room for storage, and a seriously slick tempered glass panel, BitFenix hasn't held back when it comes to kicking. Airflow could be better up front, but given how little heat we expect this machine to produce, there's an argument to be had for not needing it that much anyway, at least until you decide to upgrade at a later date.

Apart from the case, we also opted for a slightly pricier PSU, courtesy of EVGA, and some lower spec DDR4 to save a few bucks, purely because higher frequencies wouldn't particularly benefit this Intel rig in any meaningful way. Although it's not included in the pricing, using the remaining budget we snuck in a nice magnetic white 12-inch LED strip running along the top of the case as well, just to make it pop a little more. It's a small luxury, using a little extra cash, and completely superfluous, but we may as well take advantage of that tempered glass side panel while we have it.



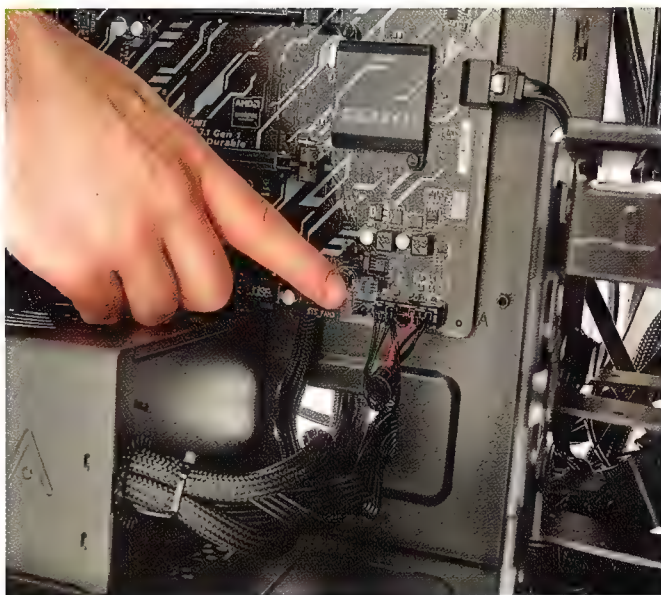
1 STOCK COOLING Intel's stock cooler design hasn't changed too much since its inception with the early Nehalem processors. Simply open up the locking mounts on each corner, push the cooler down through the holes on the motherboard until it clicks into place, then lock by turning each thread counter-clockwise. We're sticklers for consistency on this build. A smart way of keeping the cable tidy is to tie a small loop into the header, then plug it into the motherboard's CPU fan header. It looks far cleaner, and keeps it out of the way of any conflicting fans.

PARTS LIST		
PART		STREET PRICE
CASE	BITFENIX NOVA TG	\$74
MOTHERBOARD	GIGABYTE GA-Z370-HD3	\$189
CPU	INTEL CORE I3-8100	\$169
MEMORY	8GB (2X 4GB) TEAM VULCAN DDR4-2400	\$145
PSU	EVGA BT 450W	\$69
STORAGE 1	KINGSTON SSDNOW UV400 120GB	\$65
STORAGE 2	WESTERN DIGITAL CAVIAR BLUE 1TB	\$69
TOTAL		\$780

"So, what was the idea behind these two projects? In short, to keep things simple."

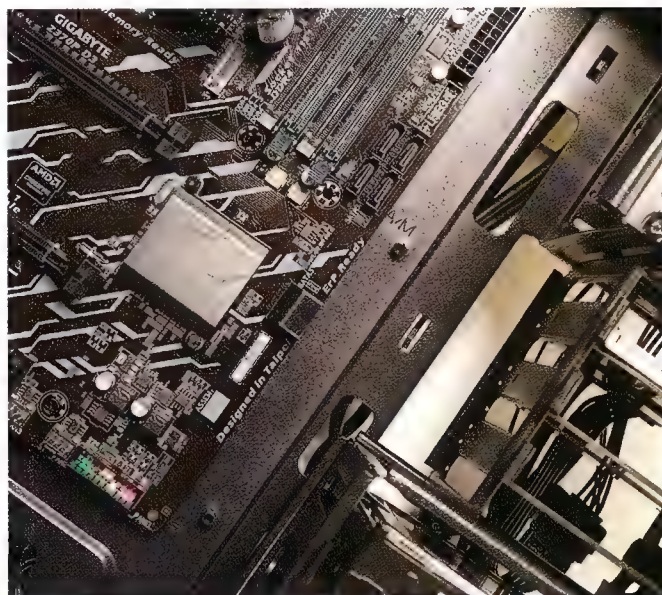


2 INTERNAL COOLING ON A BUDGET Unfortunately, unlike our competing AMD build, we don't have the luxury of running triple fans in the front of the rig for maximum airflow. So we've opted to go a little old school and instead throw the PSU fan upward. This will draw air from the chassis, use it to cool the PSU, then dump it out the rear of the case. It's not ideal for liquid-cooled builds, or if you're running a particularly hot rig, but for our low thermal producing components, it should help keep air flowing at little cost.



3 RETRO TIME

Our editor said we weren't getting hands-on enough in the photography for this story, so we decided to take it up a notch, and point at this speaker. As we've gone for such a cheap Z370 board, having access to this little beauty helps us diagnose any errors on the board. Beep. One good thing about Gigabyte's motherboards is the included front I/O header mounting bracket: simply thread your front panel connectors into the designated holes on the bracket, let them click into place, then carefully push the bracket on to the front I/O pins on the board. Our testing found that this reduced unnecessary cussing by a staggering 268% throughout the duration of a building session.



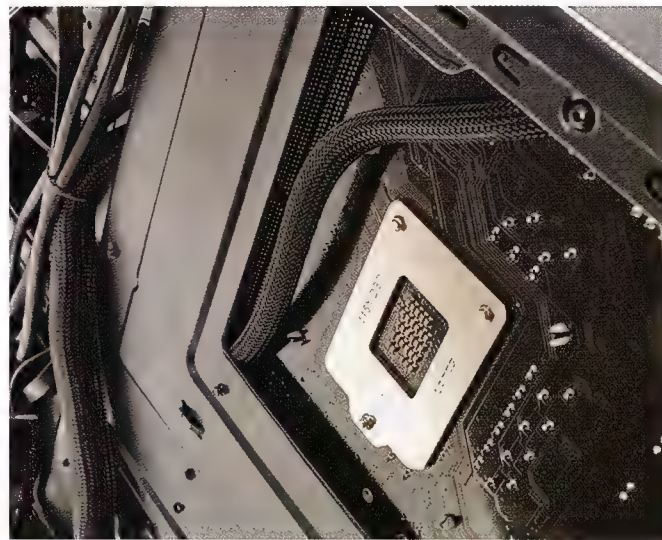
4 NOT QUITE ATX?

Unfortunately, there's still some variance with ATX motherboards, especially at the budget end of the spectrum, with most ATX motherboards actually being about half an inch shorter than the full ATX standard. This means you'll often find your motherboard can't be secured across all of the ATX stand-offs in a chassis. This can make it particularly difficult when installing memory and the 24-pin ATX power on the motherboard, because you risk warping the PCB. We can only suggest you do as much as you can outside of the case first, even install the 24-pin with the motherboard on a box first, before you install it into the chassis.



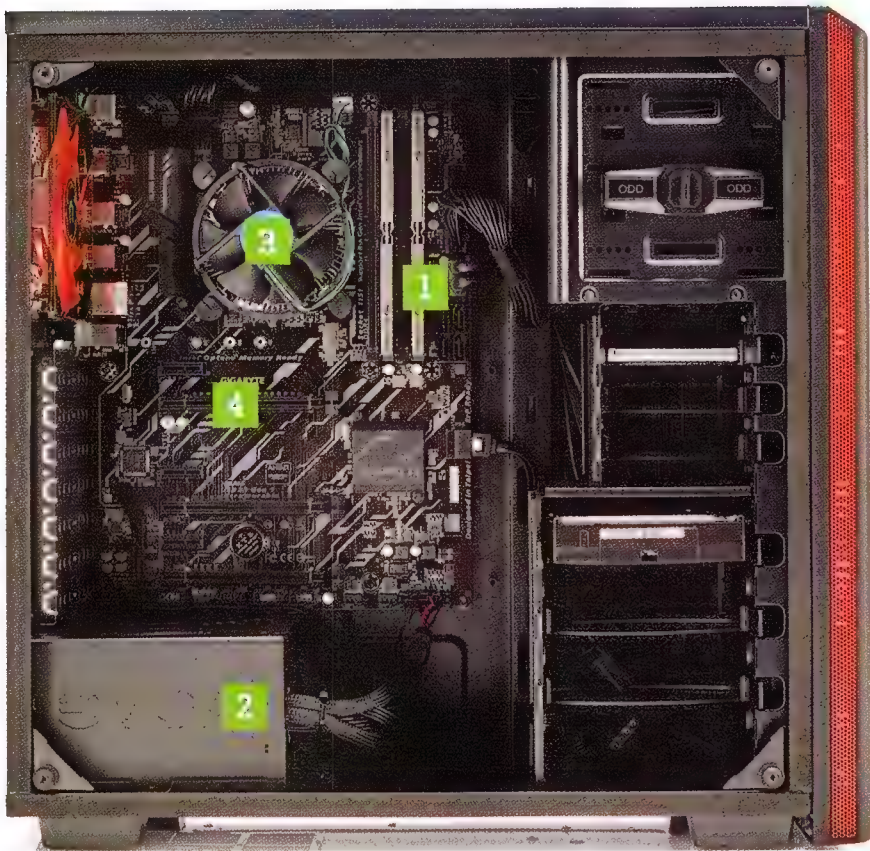
5 LIGHT UP YOUR LIFE

The one thing that isn't budgeted for in our rig is the LED strip running along the roof, which we've discreetly hidden. If we're honest, it was a last-minute decision to throw this in, just to show off the internal components, and how clean we managed to make the build, even on a budget. You can pick one of these up for around \$30, and it even comes with an adhesive back, in case your chassis isn't magnetic.



6 CABLE FRIPPERY

We've got a pretty hefty CPU power cable on our 450W EVGA PSU, which means it's a real struggle to fit it through the top pass-through in the case, and secure the motherboard down. To get around this, we've carefully positioned it below the motherboard, ahead of time, before securing it into place, keeping it tidy and out of the way. On top of that, we've kept our cables neat by tying several of them together. You'll notice our ATX power and front panel headers are bound together, along with the bundled front fan and SATA power, and the GPU and additional Molex power that we didn't need are bound at the bottom, then hidden in the hard drive cage. This keeps the cables taut, tidy and out of the way without necessarily tying them to the chassis itself.



1 Team Group is not a brand we usually go with, but as its memory, at a fairly commonplace frequency, comes with a nice heatsink, why not?

2 EVGA's \$69 450W PSU comes with a sleek design and entirely black cables. Now, that's what we call epic.

3 Intel's stock cooler is certainly good enough to cool its lineup of low-powered chips, although it pales in comparison to the likes of AMD's Wraith cooler.

4 Obvious upgrades for this rig would be a GTX 1050 Ti or higher, and potentially an M.2 SSD as well, then we'd be cooking.

Cut-price performance

When it came to putting our budget Intel build together, not a lot went wrong. It was pretty much plug and play. We did have a slight issue installing the eight-pin EPS power at the top of the board, but that was quickly resolved by running the cable under the motherboard itself. It's a pretty neat fix, although admittedly not one we have to do very often. We could have perhaps dodged this entirely simply by installing the PSU with the fan facing downward, but losing that additional airflow pull-through would have been detrimental to overall temps. Perhaps, if we'd grabbed an additional 120mm fan

for the front, we would have considered it, but this was the best way to run it as things stood.

The other bugbear we had to deal with was the incompatibility with the stand-offs. Yep, the Z370 HD3 is labelled as an ATX board, but it's simply not wide enough to fit on the additional ATX stand-offs in the chassis. That's not an issue with the case, more with the board. Even if the PCB lacked any additional features, we'd like to see a consistent size for the form factor. After all, it's not much of a form factor if it doesn't conform across standards, at least with the stand-offs.

The biggy with this rig is performance. Obviously, this system was going to be demolished by our budget zero-point — that's \$1,100 of kick-arse hardware, including a six-core Ryzen 5 processor, a GTX 1060, and a Samsung 960 Evo — but showing that is a good example of the price-to-performance sweet spot. It's something that sits in the middle, between the absolute high and low ends of hardware. There's a point where you'll end up with diminishing returns in both directions; after all, for twice the cost, you get a hell of a lot more than twice the performance in almost all scenarios, bar computational tasks, and that's pretty insane.

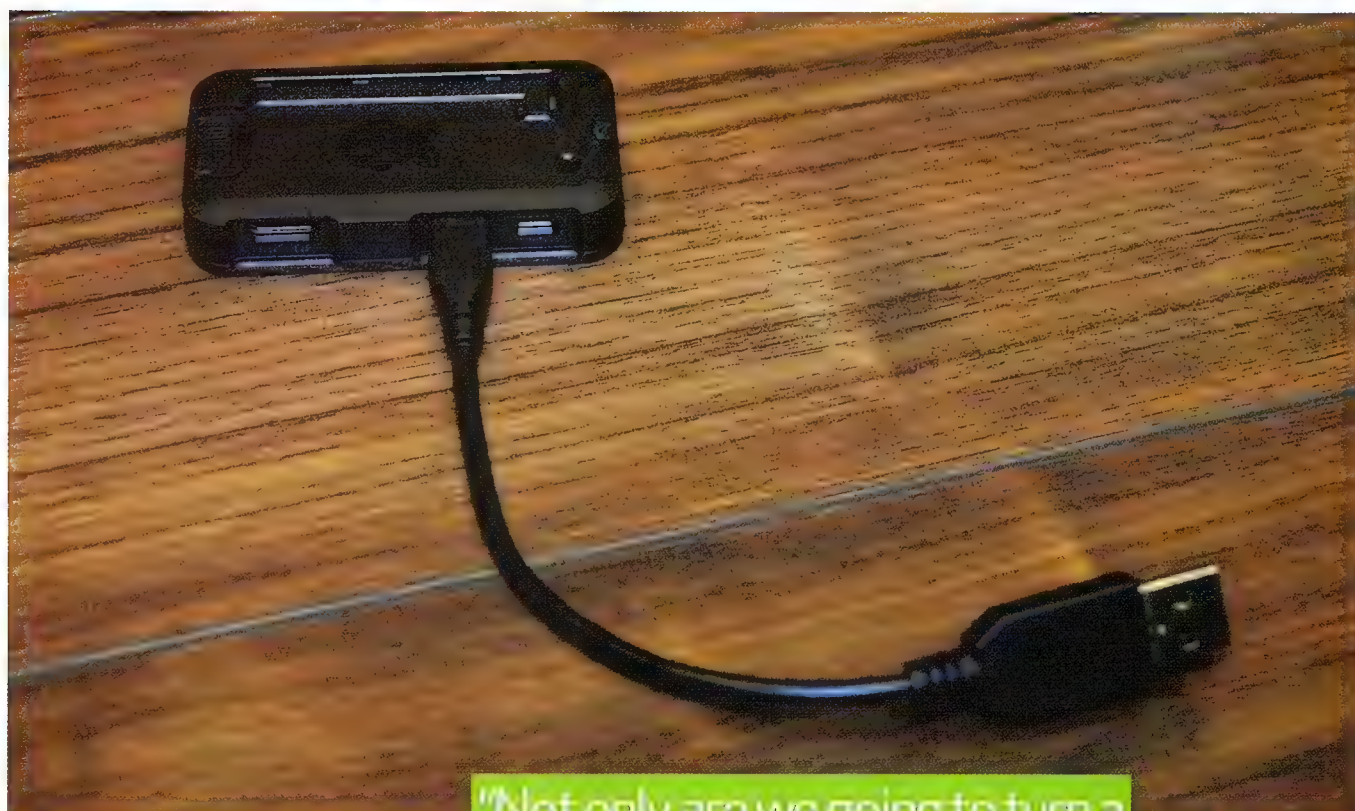
In a similar vein, this Intel build has taught us how incredible the Ryzen proposition is. Take the APU in the AMD build on page 88 — the difference in graphical performance is staggering, especially when you're on a budget. But even ignoring that, we've been referring to the Core i3-8100 as possibly the most important CPU in Intel's latest line-up, essentially performing like a Core i5-6600K, but at a fraction of the cost. The thing is, against the Ryzen 5 1600 featured in our zero-point machine, both look like paperweights, because the 1600 nearly doubles the performance in comparison, but for the same money as that i5 today. ■

BENCHMARK RESULTS		
	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI (INDEX)	1,152	541 (-53%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	3,400	540 (-84%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	1,720	372 (-78%)
RISE OF THE TOMB RAIDER (AVG FPS)	60	5 (-92%)
TOTAL WAR: WARHAMMER II (AVG FPS)	46	3 (-93%)
TOM CLANCY'S GHOST RECON WILDLANDS (AVG FPS)	39	2 (-95%)
3DMARK: FIRE STRIKE (INDEX)	11,101	1,183 (-89%)

Our APC Labs Test PC consists of an AMD Ryzen 5 1600 @ 3.2GHz, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

Turn the Raspberry Pi into a remote hacking tool

Using a few scripts, Calvin Robinson is going to turn a Zero W into a 'RubberDucky' pentesting tool.



RubberDucky USB devices are great penetration-testing tools. This device is plugged into a target computer, and the USB drive tricks the computer into thinking it's an HID keyboard device in order to gain privileged access. Keyboards naturally provide a user with unrestricted access to the computer, in ways that a USB stick wouldn't normally be able to.

Pre-configured 'Ducky' scripts are then run on the target machine to prank the user or provide unauthorised remote access. Not only are we going to turn a Raspberry Pi Zero W into a USB device capable of running Ducky scripts, we're also going to gain remote access to the target machine in order to select which scripts we'd like to run, and gain shell access on the target PC.

For the sake of this tutorial, we're assuming the target is running Windows and we – the attacker – are running a variant of Linux, but Rubber DUCKYS essentially work on any operating system. Scripts are available for Windows, Linux and OS X.

"Not only are we going to turn a Raspberry Pi Zero W into a USB device capable of running Ducky scripts, we're also going to gain remote access to the target machine."



1 PREPARATION — THE HARDWARE

In order to get our Raspberry Pi set up as a USB device, we'll need:

- A long USB cable with power adaptor
- A USB hub (for connecting multiple USB devices at the same time)
- A USB Ethernet adaptor and Ethernet cable (to gain internet access without having to mess around with Wi-Fi settings)
- A Mini HDMI-to-HDMI cable and a monitor to connect your Pi to
- A standard USB keyboard
- A microSD card

If you really want your Pi to look like a USB device, take a look at the N-O-D-E case (github.com/N-O-D-E/Dongle). Some soldering may be required. If you're not using the N-O-D-E, you'll need a small USB to Micro-USB cable for connecting the Pi to your target PC.

2 PREPARATION — THE SOFTWARE

Download the latest version of Raspbian Stretch Lite, and some software to write the image onto your microSD card — we recommend Etcher for this.

Once you've got Raspbian Stretch Lite installed, plug in a monitor and keyboard and boot your Pi. You can also use SSH for this step, if you can find the IP address of your Pi by checking your router or by using a network sniffer such as Angry IP Scanner. Once in, the default login details will be **username: pi** **password: raspberry**

Next up, we'll need to install git and download a clone of P4wnP1, which is the toolset that turns our Pi into a USB device.

3 INSTALLATION — GIT-CLONING P4WNP1

Just run the following lines one by one:

```
mkdir ~/P4wnP1
cd ~/P4wnP1
sudo apt-get install git
git clone --recursive
https://github.com/mame82/
P4wnP1
./install.sh
```

Grab a cup of tea, as installation may take some time. Once complete, note down the Wi-Fi name, key and SSH access displayed on the screen. We can of course change these later.

4 TEST THE CONNECTION

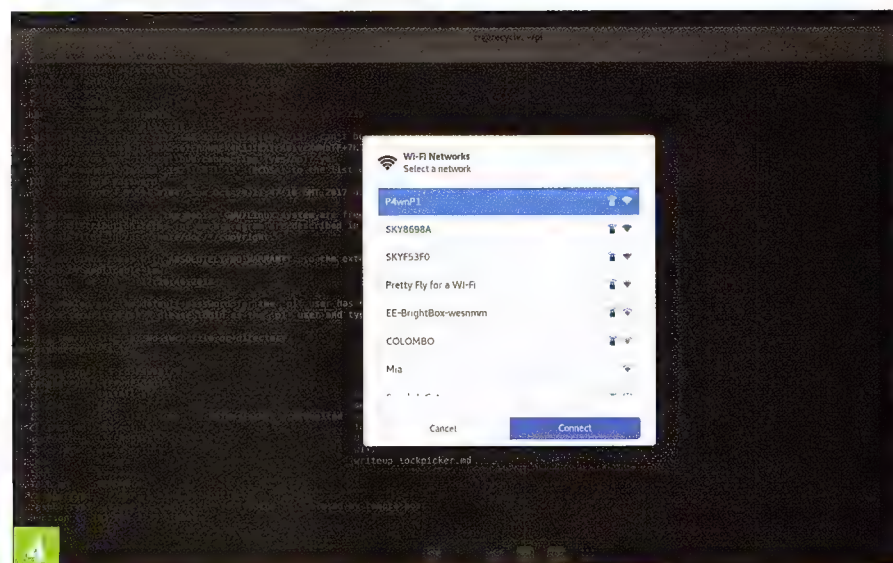
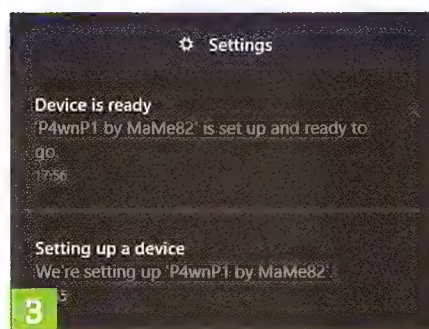
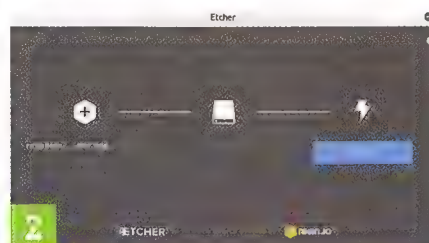
Now that everything is set up, we should have a basic working P4wnP1 USB device. Before we set up our payload and customise our settings, it's good to test that everything is working. We'll need two computers for this, one to be used as a target and the other for our remote control 'attacker'.

Plug the Pi into a target machine — which must be a working computer

that is turned on — using the Pi's middle USB port (the one for data, not power). You should notice a couple of things: the target machine will display discrete pop-ups saying 'Setting up a device' followed by 'Device is ready'. At the moment, this new USB device will be called 'P4wnP1 by MaMe82' but we can change that later. On the attacker's machine, we should see a new Wi-Fi network called P4wnP1, which means all is working as intended.

5 CUSTOMISE YOUR USB PI

Now that the Pi is up and running, we'll want to either plug it back into a screen and keyboard, as we did earlier, or connect remotely over SSH at the address we noted down (172.24.0.1). Change directory into ~/P4wnP1 and run nano setup.cfg. Here, you'll see a whole range of settings, but ignore these for now as they'll mostly be overwritten by our payload config. What we want to do



next is scroll to the end of the document and uncomment our payload of choice. For this tutorial, we'll be using `hid_backdoor_remote.txt`, which enables all the fancy RubberDucky functionality. Be sure to comment out the `network_only.txt` payload with a `#`. Save and exit.

6 SETUP YOUR PAYLOAD

Change directory to payloads and nano-edit the appropriate config file, in this case `hid_backdoor_remote`. Here you may want to change several settings, but most importantly `WIFI_ACCESSPOINTNAME` and `WIFI_ACCESSPOINTPSK`, which are of course the SSID and password required to remotely connect to your USB Pi.

There are some rather interesting settings in this payload, namely the reachback connection or AutoSSH. This will enable the Pi device to automatically connect to a server of your choosing, via SSH, to essentially provide a backdoor tunnel.

7 HACK VIA WI-FI

While the AutoSSH functionality is fantastic, particularly for out-of-sight or long-range remote hacking, for the purposes of this tutorial we're going to stick with line-of-sight and/or short-range remote hacking via a local Wi-Fi connection.

Pop the Pi into a target machine and connect remotely via SSH to `pi@172.24.0.1`. A more discrete way of doing this, rather than using a laptop for attacking, could be to use an Android mobile phone with a Terminal/SSH client installed. Once connected, type "help" for a list of commands.

8 BASIC USE

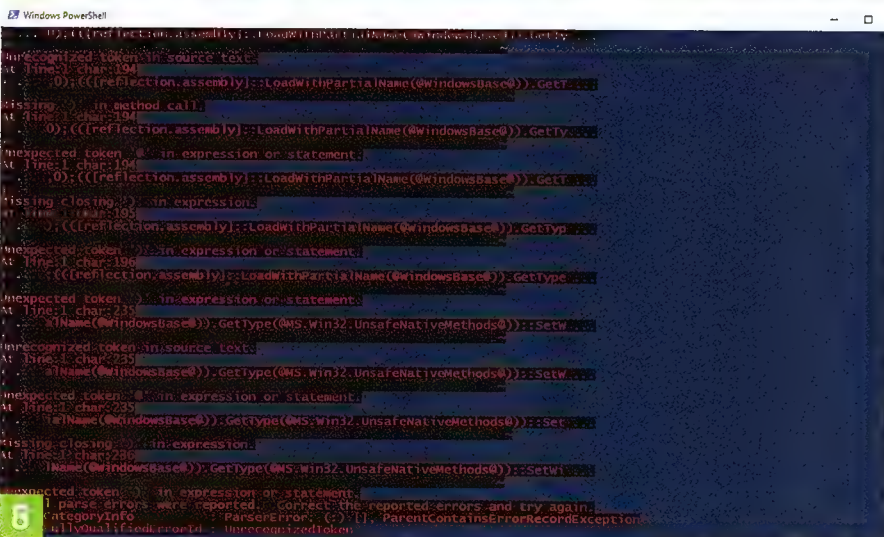
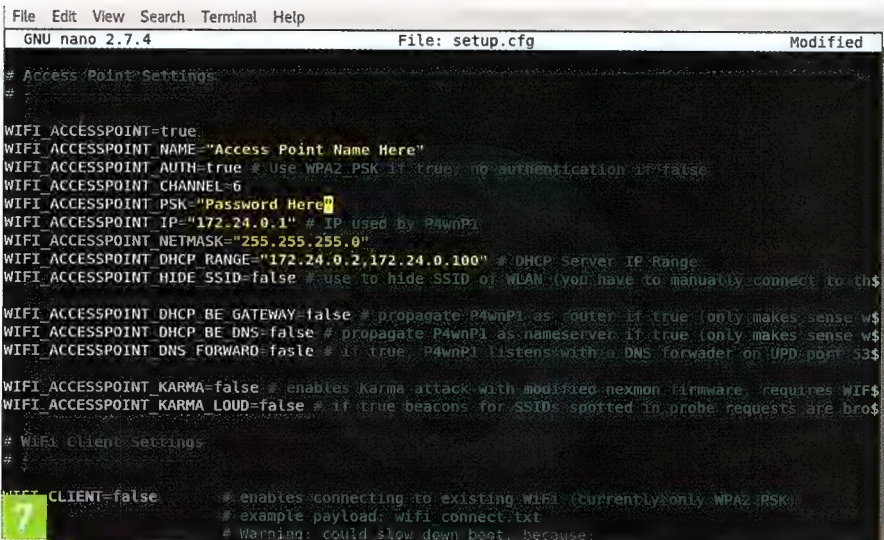
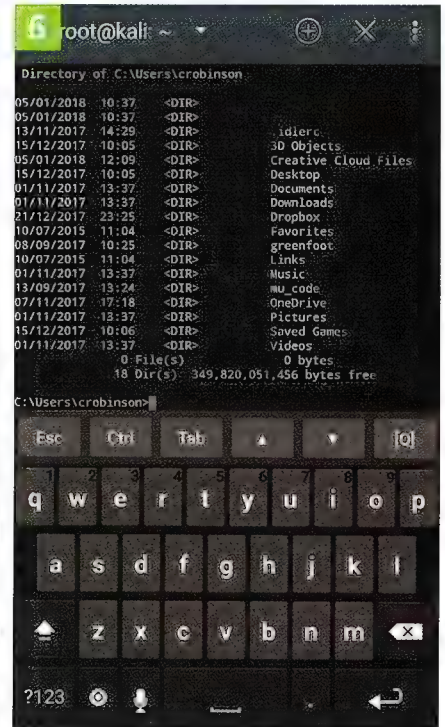
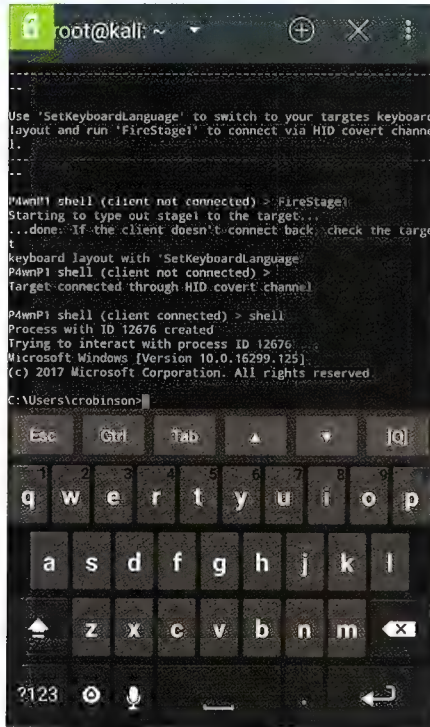
By default, P4wnP1 shell will say 'client not connected'. To gain remote access to the target machine, we'll

need to initiate the `FireStage1` command. This will briefly open a PowerShell window on the target, before taking advantage of a few exploits and disappearing again. We now have pretty much full control over the target machine – whatever the end user has access to, so do we.

Typing `shell` will give an MS-DOS-style command prompt, where you'll be able to use `cmd` as a regular user. Try running some basic Windows commands such as `dir` to see what happens. Type `exit` to quit the shell.

9 PLAYING WITH RUBBERDUCKY PAYLOADS

Having shell access is great, but we're really here for the RubberDucky scripts. To run one of these payloads, simply type `SendDuckyScript` and you'll be greeted with a list of all the scripts currently stored on the microSD. By default there are seven scripts to play with, but there are also hundreds of other pre-configured scripts available online. We've linked to Daren Kitchen/Hak5's payloads in



the Resources tab, where you'll find dozens of high-quality payloads.

P4wnP1-youtube.duck launches a YouTube video on the target machine, Trigger_eicar.duck checks for an installed antivirus. AltF4_Return.duck, AltF4.duck, Stickykey.duck and Stickykey_remove.duck are quite self-explanatory, while HelloWorld.duck opens a NotePad and types the message 'Hello World'.

10 EDIT RUBBERDUCKY PAYLOADS

13 We can open .duck files in a text editor such as nano and make our own customisations. HelloWorld.duck is a great place to start – try fiddling about with it. By default it looks like this:

```
GUI r
DELAY 500
STRING notepad.exe
ENTER
DELAY 1000
STRING Hello World
ENTER
```

11 CONFIGURE RUBBERDUCKY PAYLOADS

The delays are there to give the computer a chance to load software. 'GUI' opens Windows' Run dialogue window; our script then waits a few milliseconds before typing the string of text notepad.exe and pressing the Enter key. After another short delay (for Notepad to load), our script types out another string. We could of course edit this string or add multiple strings below it, to display our own custom messages on the target's screen:


```

File Edit View Search Terminal Help
P4wnP1 shell (client connected) > Client confirmed close of remote channel with ID 11
P4wnP1 shell (client connected) > help

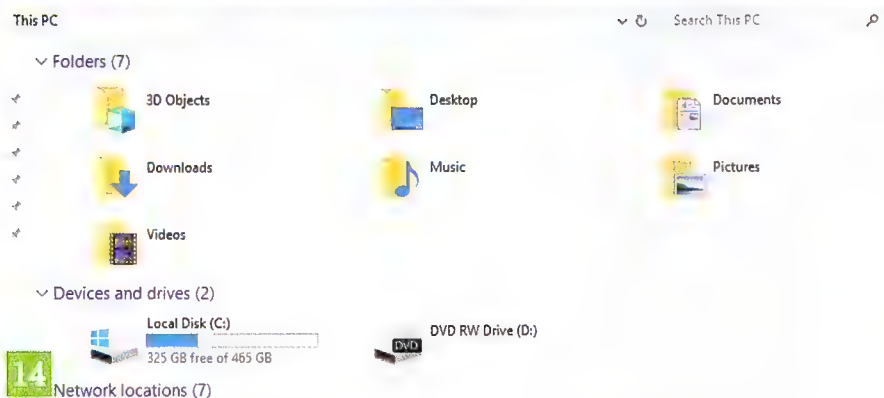
Documented commands (type help <topic>):
=====
CreateProc  GetClientProcs  KillClient  SendKeys    echotest
FireStage1  GetKeyboardLanguage  KillProc    SetKeyboardLanguage  help

Undocumented commands:
=====
GetClientTimeout  SetClientTimeout  exit    lls    pwd    upload
SendDuckyScript  cd              interact  lpwd   shell
SendMouseScript  download       lcd       ls     state

P4wnP1 shell (client connected) > SendDuckyScript
No script given or given script not found
Choose script by number or name:

0: P4wnP1 youtube.duck
1: trigger_eicar.duck
2: stickykey remove.duck
3: HelloWorld.duck
4: AltF4_Return.duck
5: AltF4.duck
6: mspaint.duck

```



STRING Please remember to lock your PC and protect your USB ports.

12 ADD MORE RUBBERDUCKY PAYLOADS

By creating .duck text files in /P4wnP1/DuckyScripts, we can collate as many RubberDucky scripts as we like, and they'll all be listed by the SendDuckyScript comment on our USB Pi.

```

GUI r
DELAY 500
STRING iexplore -k http://
fakeupdate.net/win10u/
index.html
ENTER

```

This script loads a full-screen 'Windows Update' screen as a prank.

13 HOW TO USE HIDDEN COMMANDS

There are a few handy commands not listed under the help command, such as these:

KillProc Try to kill the given remote process.

KillClient Try to kill the remote client.

CreateProc This remote PowerShell method calls core_create_proc in order to create a remote process.

GetClientProcs Print a list of processes managed by the remote client.

Interact Interact with processes on the target.
Usage: Interact <process ID>.

SendKeys Print out everything on target through the HID keyboard.
exit Exit the Backdoor payload and return to the Pi's command line.

state See details about the target computer.

echotest If the client is connected, command arguments given should be reflected back.

14 PI COMMANDS

P4wnP1 also allows for the use of some Linux commands, regardless of the target operating system:

lcd Change directory on the Pi.

lpwd Print the name of the Pi's current directory.

lls Print the contents of the Pi's current directory.

pwd Print the target's current directory.

ls List contents of the target's current directory.

cd Change the target's current directory.

upload Upload a file from the Pi to the target. Usage: upload <Pi/

Where'd it go?

A really simple but fun prank is the old Alt-F4 script. This will press 'Alt-F4' on the target's screen, which in Windows immediately closes the currently active program, followed by Enter to bypass any 'Save' dialogue that may pop up to prevent the program from closing immediately. If you have line-of-site, this one can be a real treat, as you can run it every time the target re-opens the program.

```

ALT F4
DELAY 500
ENTER

```

directory.filetype> <target/directory.filetype>.

download Download a file from the Pi to the target. Usage: download <target/directory.filetype> <Pi/directory.filetype>.

run_method This is undocumented for now.

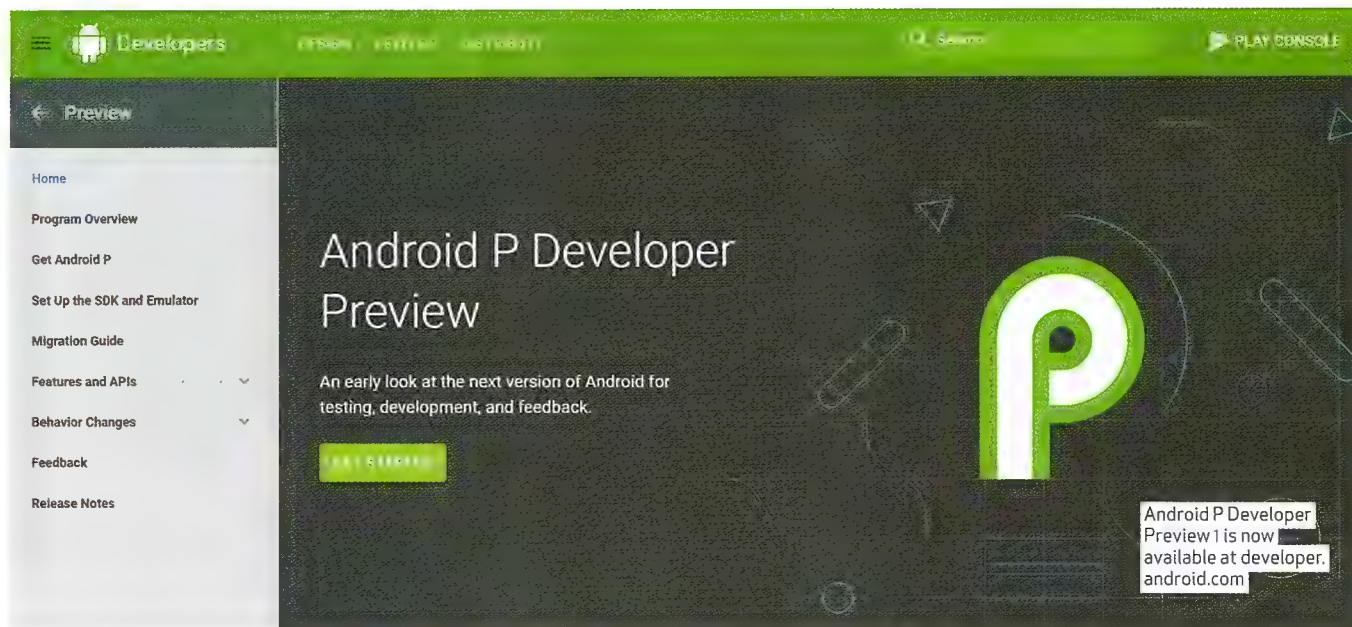
15 OBTAINING USER CREDENTIALS

Of course, we've only used the network_only.txt and hid_backdoor_remote.txt P4wnP1 payloads in this tutorial, but others are available. Try switching to the hakin9 tutorial/payload.txt instead, as this takes things a step further.

Instead of only replicating an HID keyboard interface, hakin9 also replicates an RNDIS network device and a USB mass-storage device. Therefore, we can run a script that steals a user's credentials via PowerShell and then saves them directly to the USB. This would mean you could plug in the USB device, run the script, pull it out and walk away. The target would be none the wiser.

16 OTHER PAYLOADS

Once you're comfortable with hid_backdoor_remote and hakin9, there are a number of other payloads to play around with in P4wnP1. Win10_LockPicker attempts to grab Windows 10 login details, hid_mouse sets up the Pi to emulate mouse functionality instead of a keyboard, offering a completely different toolset, and wifi_connect is the infamous AuthSSH attack. ■



Test driving the Android P Developer Preview

Samsung Galaxy S9 and Google Pixel owners are among the few to see Oreo so far, but the first preview for Oreo-successor, Android P, has already landed. Darren Yates investigates.

It may not yet have an official name, but the Android Developer Preview Show has rolled back into town, with Google unveiling the first preview of Android P, the follow-up to Android 8.x/Oreo released last August. With Oreo presenting so many architectural changes under the bonnet compared with its Nougat/7.0 predecessor, Android P looks set for more visible modifications, from its new rounded-corner design to its heavy overhaul of notifications, support for new centre cutouts, even a new home for the clock. We dive into Android P Developer Preview 1, round up the new big-ticket items and some of the less-well-known changes coming to the next version of Android.

INDOOR LOCATION TO WITHIN ONE METRE

GPS (global positioning system) can sort out your location outdoors quite comfortably, however, walk through a large shopping centre or corporate building and you're still on your own. Android P aims to fix this by incorporating 802.11mc, a Wi-Fi protocol that's been demonstrated by Intel since at least 2015, featuring what's known as 'Fine Time

Measurement'. Android P phones will be able to ping nearby Wi-Fi access points that support this new 'Wi-Fi Round Trip Time' or RTT and receive back data packets featuring timestamps measured in nanoseconds. Have three or more of these access points and Android P will triangulate your location within a building. You won't need to connect to the access point to get these timestamped packets and the ping process is one-way only – your device can ping the access point, but not the other way around. Google says it should be accurate to 'within 1 to 2 metres'. While indoor navigation is one clear application, the big-G also sees a future for what it calls 'disambiguated voice control' – this combines smart-home tech with indoor location, so that Android P knows exactly which light switch you're talking about when you say 'turn off this light'.

NOTCH COMES TO ANDROID

When I first saw the notched display on the Apple X phone, I thought at the time 'Yeah, nah', but clearly, I won't score a design gig at Google any time soon, for it seems Android is set to roll out its own notched-display support.

The notch is a necessary evil at the moment if you want a phone with

front-facing camera sensors plus a full frameless 'edge-to-edge' display. If you look at Android P via Android Emulator, you'll see under 'Settings' and 'Display' there's a 'display theme' option that gives you three different cutout styles – 'Narrow display cutout', which appears designed for a single camera sensor and has a depth of half the status bar height, 'Tall display cutout', which uses the full status bar height, and 'Wide display cutout', providing enough space for at least two selfie sensors. The idea is that app developers can dial up the different cutout options and ensure their apps will work when these cutouts appear in real phones.

TIME-SHIFTING

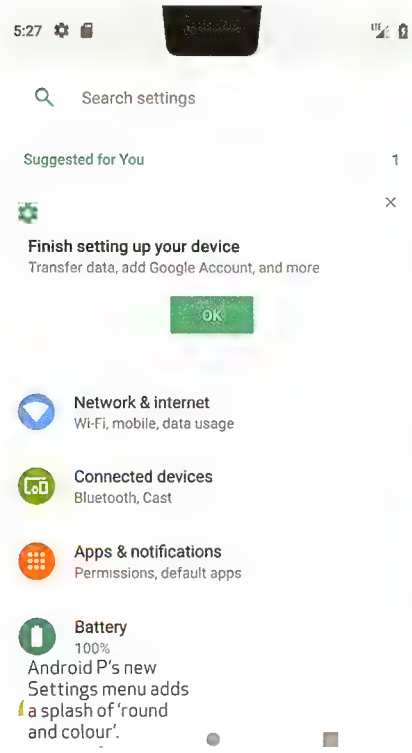
However, to accommodate these cutouts, it seems Android P has had to introduce another change and that's moving the clock from the far-right to the far-left of the status bar. For phones with notches, it's probably understandable, since there's less room for system notification icons on that right-side if the clock remained there. Still, it'd be a nice touch if Android P eventually gave you the option to choose which side you want the clock, in case you don't end up with a notched phone.

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	0.3%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	0.4%
4.1.x	Jelly Bean	16	1.7%
4.2.x		17	2.6%
4.3		18	0.7%
4.4	KitKat	19	12.0%
5.0	Lollipop	21	5.4%
5.1		22	19.2%
6.0	Marshmallow	23	28.1%
7.0	Nougat	24	22.3%
7.1		25	6.2%
8	Only 1.1% of Android devices carried Oreo by February 2018.	26	0.8%
		27	0.3%



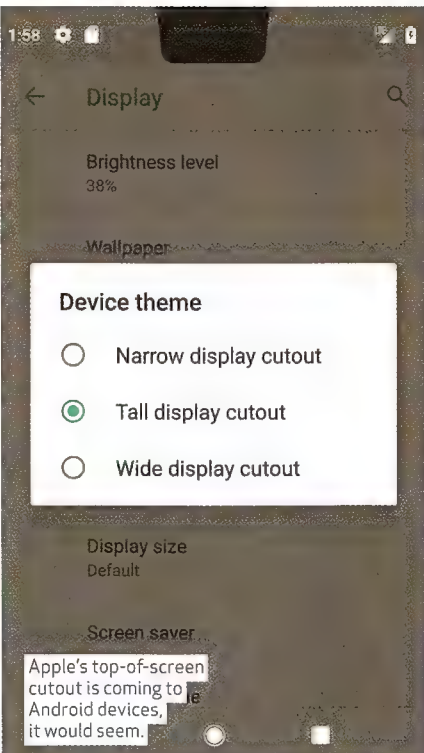
LAYOUT DESIGN CHANGES

The other thing you'll notice with Android P is the change in panel layout design – rounded corners are now the order of the day. Panels on the home screen have also received a transparency layer – you'll see it when you pull up the installed app menu and just see the homescreen icons behind. Android also takes the 'rounded' concept into a Settings page refresh, where icons are not only rounded but also pick up a splash of colour. You'll also receive prompts for tasks you should do next (such as setting up your Android account if you haven't yet done so).



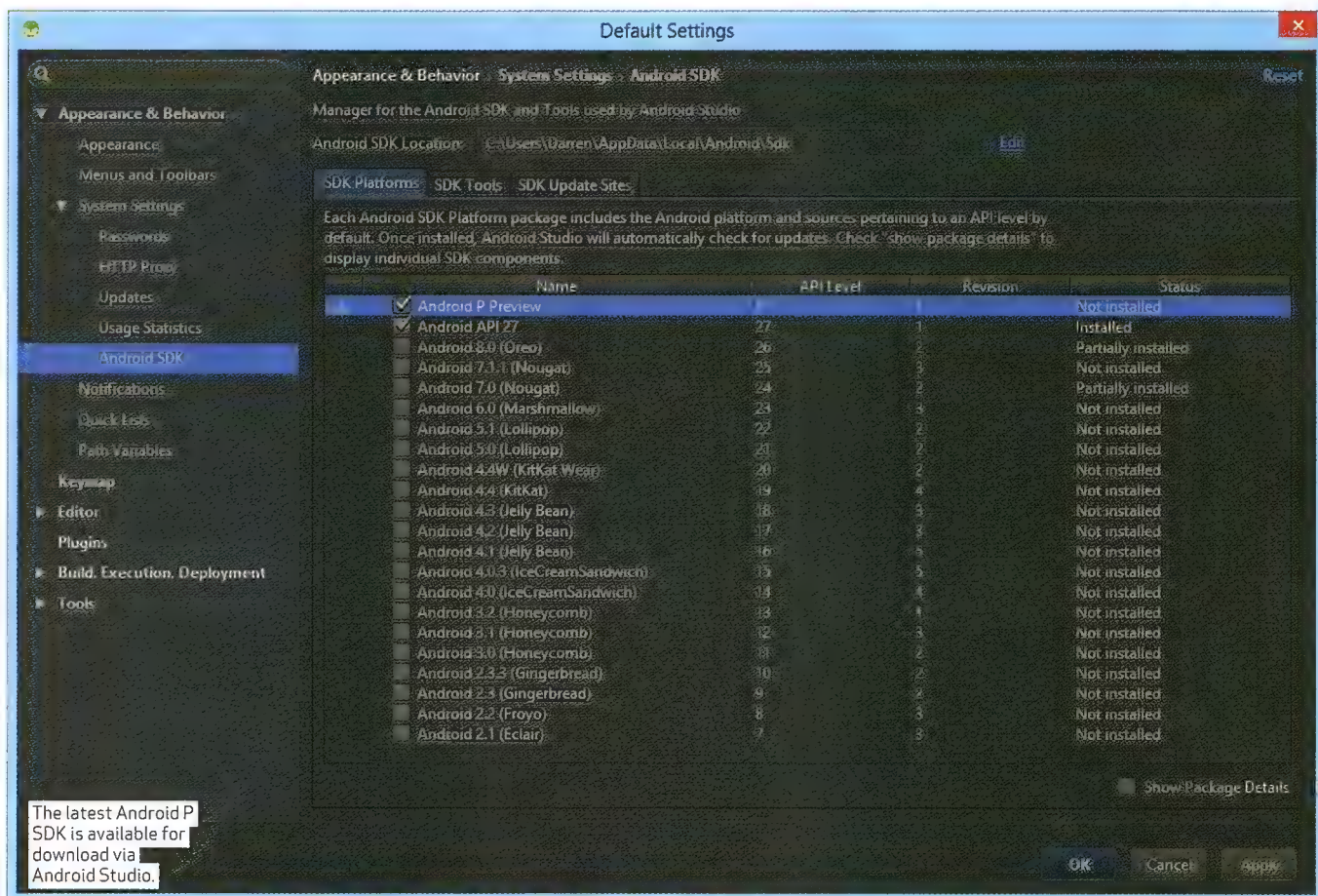
MULTI-CAMERA STREAMS

The camera may be the new battleground for the latest flagship phones from Samsung and Apple, but Android is giving all manufacturers and app developers a leg-up with new multi-camera support for Android P. Through a new 'application programming interface' (API), app makers will have simultaneous data stream access to multiple camera sensors. Google expects this will lead to new apps supporting a range of visual effects from the popular out-of-focus 'bokeh' background effect to stereo/3D photos. Nokia already does something similar to this on the Nokia 8 that takes

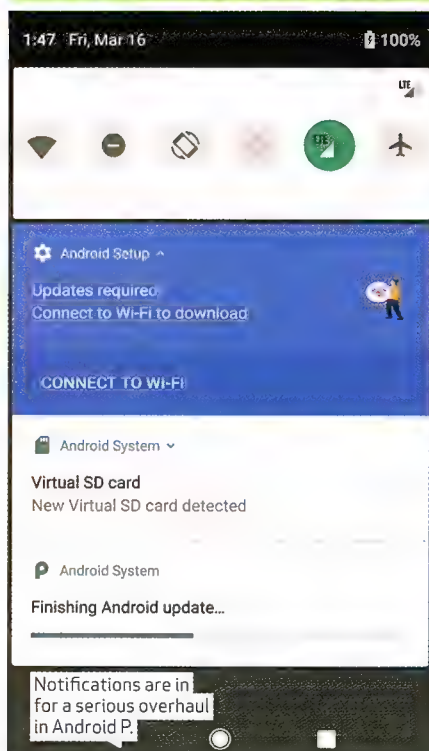


simultaneous photos on its front and rear lenses. Another new feature is support for USB/UVC (USB Video Class) cameras. We've looked at external video devices before, such as low-cost USB microscopes and EasyCAP video capture modules. However, in the past, these devices have relied on apps providing their own UVC support. It's also the reason why the mix of USB camera and app isn't always easy to get right. By incorporating UVC support into Android P, it should be far easier to connect these external camera devices up to your phone or tablet (once new Android P-ready apps appear, that is).





"If you use apps that employ the fingerprint scanner on your device, you may begin to see a different dialog screen when authenticating."



CHANGES TO NOTIFICATIONS

Google has been tinkering around with Android notifications for a while now, most recently with replying to messages within the notification panel itself. Android P ramps this up further by adding support for images in messaging notifications. There's also new support for personalising participants. A new 'Notification.person' class allows code developers to add in avatar icons and other identifiers in the notification panel. You'll also be able to save replies to notification messages as drafts and retrieve them.

Add in the new design changes, the white and rounded-corners theme and the notification panel is fast becoming a full one-stop shop for all sorts of immediate-response social messaging.

SECURITY HARDWARE

With the rapidly reducing cost of microprocessors, there's a push to turn previously software-only tasks and features into dedicated hardware. The coming boom in neural network hardware thanks to new co-processors

is one example and Android P will bring with it support for another. Even before the days of Android 6.0/Marshmallow, Android has supported cryptographic functionality through a 'hardware abstraction layer' called Keymaster HAL, essentially an interface that allowed Android to offer stronger security to apps and data. It's quietly received updates on each Android release since, but with Android P, supported devices will be able to push the Keymaster HAL into a separate hardware module Google calls a 'StrongBox Keymaster'. Google says this module will have its own CPU and storage, plus a proper random-number generator, a key building block for cryptographic security. The idea is to prevent malicious software from being able to tamper with app packages or sideload themselves into the system without the user's knowledge.

IMPROVED PRIVACY

Android P is also cranking up the privacy measures, particularly against background apps. New Android releases are a bit of a dilemma for software developers and users because many of the new features require app updates coded for that particular Android release or (API) version. Yet for certain features, Android can force all apps into submission, regardless of whether they programmed for that feature or not. Google takes this later path to tighten up privacy further against background-running apps. From P onwards, background apps will no longer

have access to the device cameras or microphone, plus there are changes to the way sensors, such as the accelerometer, work — they'll no longer trigger an event notification for apps running in background mode.

NO MORE ASECs

Android Secure Encrypted File (ASEC) format dates back to Android 2.2/Froyo and was Google's way of securely storing apps on SD card storage to overcome limited internal device storage of the day. However, the writing has been on the wall for ASEC for some time — Google deprecated the format back in Android 6.0/Marshmallow when it launched 'adoptable SD storage', which we looked at in last month's Android masterclass (APC 453, page 100). By the time Oreo arrived, you could no longer install apps using ASECs, although you could still read them. Now with Android P DP1, the ASEC functionality is gone altogether.

It's unlikely any device starting life with Android 7.x/Nougat and still using ASECs will likely see Android P, so the lack of ASEC support is unlikely to affect too many users. However, it should flag the importance of knowing the feature changes a new OS brings before you install the update to your device. Any OS update will give you new features — but you may lose one or two as well.

FINGERPRINT DIALOG

If you use apps that employ the fingerprint scanner on your device, you may begin to see a different dialog screen when authenticating, thanks to Android P. Google introduced the `FingerprintManager` class back with Android 6.0/Marshmallow to handle this task. However, it still relied on the actual fingerprint scanning/checker app to provide the dialog box to communicate with the user. Android P brings this task back in-house, replacing `FingerprintManager` with a new `FingerprintDialog` class. The benefit is that in future, all apps using fingerprint security will eventually show the same standard Android dialog panel, something Google hopes gives user added confidence that the fingerprints they're being asked to provide are being checked by a legit process.

WHEN WILL WE SEE ANDROID P?

If Oreo is any guide, the only devices with a realistic shot of seeing Android P any time this year are Google's own Pixel range and that'll likely be in the week, if not the day, of launch.

To be fair, Oreo represented a major architectural change to the operating system and that may be a factor in the seemingly-low pick-up of Android 8.x at the moment, with manufacturers



Google's Pixel 2 XL phone will likely be among the first to see Android P.



Samsung's new Galaxy S9+ should receive Android P early in 2019.

requiring more time to adapt Oreo to existing hardware. It may well be that come time of Android P, the hard work will be done, allowing for a faster release of updates. Even so, it'll be the latest flagship models receiving updates first, followed by upper-mid-range devices.

INSTALLING ANDROID P NOW?

Android P DP1 is available as a download via Android Studio and the Android developers' website, but it's also available as an install image for Google's Pixel and Pixel 2 phone series. However, at this stage, Google recommends against attempting to use it as an every-day driver and should only be used by developers to understand the Android P changes in a hardware setting. What's more, you have to wipe your device's storage to both install it and uninstall it, plus it won't auto-update to future previews. It's also likely there'll be features that aren't fully implemented yet, so we suggest you stick to a virtual device view until more previews are released.

PEAK ANDROID?

Earlier this year, market research firm Gartner announced the first ever global decline in smartphone sales for the last quarter of 2017. Now as treasonous as it may sound, it raises the question, have we hit 'Peak Android'? Looking at the Android platform distribution figures

for February 2018, just 1.1% of devices were carrying the Oreo operating system six months after it launched.

Yet as poor as that figure may look, it's almost the same as Android 7.x/Nougat after the same on-market period last year. Arguably the more pressing and complex issue is that of Android fragmentation, what I call the 'comet tail' of Android release distribution. As of February 2018, less than 30% of Android devices operated either Oreo or Nougat versions of the OS. Google may well release security updates, but how many of these updates reach devices running Android 6.0/Marshmallow (still used on 28% of devices as of February 2018), Android 5.x/Lollipop (just under 25%) and Android 4.4/KitKat (12%), many of which have been abandoned by their manufacturers?

MORE TO COME

We'd suggest we're just seeing more 'above the waves' features so far from Android P. Oreo was a significant technical jump over Nougat, so while Oreo may not have had as many visible changes, the changes 'beneath the waves' were still considerable. Still, this is only the first of five Developers Previews before Android P before is released, likely in August this year, with the second preview not due until early May — it could mean there are still more new features to come. ■

LEDs light green going up and red back down as audio signal increases.

Make an Arduino-powered audio light show

Turn your favourite music into your own personal light show with an Arduino Nano and a 12-bit RGB LED ring. Darren Yates explains how.

The clever and popular WS2812B RGB LED contains tiny red, green and blue LEDs in each module. It's popular and clever because you can string up to 300 of them together and control each individually with just one wire. We introduced the 12-bit RGB ring in our January issue (APC 450, page 104). This time, we're feeding audio into the Arduino Nano's analog-to-digital converter (ADC) to turn the RGB ring into an audio-controlled light show.



Our Audio Light Show uses an Arduino Nano and 12-bit RGB LED ring.

PEAK-POSITION METER

We're building what's called a 'peak position meter'. We use the ADC to capture audio, we analyse it, looking for the peak amplitude over 255 consecutive audio samples. The 12-bit ring is divided into two vertical halves, starting at the bottom, with LEDs on each side lighting up sequentially in proportion to the peak signal value. On the initial rising progression, the LEDs light up green, but as the peak amplitude hits the top LED and



This 12-bit RGB LED ring sells on eBay for \$2, but requires soldering skills.

continues rising, the LED colour changes to red and the progression continues back down. Or to put it simply, as the signal amplitude goes up, the LEDs light up in green, then back down again in red.

SIMPLE AUDIO SAMPLING

The ADC inside the Arduino Nano's ATMEGA328P microcontroller chip is an incredibly useful feature. However, rather than using some of our overclocking tricks to boost the sample rate, this project works happily just using the standard `analogRead()` function. This gives us a sample rate of approximately 9.8kHz and an audio bandwidth of just under 5kHz.



A 3.5mm stereo headphone splitter will be useful for this project.

DCBIASING

The ADC's job is to convert the DC value of the voltage into a 10-bit number that's proportional to it. If the DC voltage is 0V, the ADC records zero. If the DC voltage is 5VDC, it records '1023' (two to the ten minus one). If we set or 'bias' the ADC input to 2.5VDC, the steady state reading from the ADC will be 512, since that's halfway to 1024 (in practice, it'll vary slightly on the resistor value tolerances). If we subtract 512 from the ADC reading and take the absolute value, we now turn each sample into a positive number from 0 to 512 and use these to determine the sequence in which the WS2812B LEDs in the ring light up.

First up, you'll need the source code for this project and you'll find it on the website at www.apcmag.com/magstuff. We've built our Audio Light Show on a tiny 170-tiepoint breadboard. Because the Nano board doesn't have a convenient link to 5VDC and GND near the A1 analog input pin, we cheat – we set digital output D13 'high' to create a DC voltage of (nominally) 5VDC and we turn analog input A5 into a digital output, push it 'low' and get our pseudo-GND rail. The current flowing through these resistors is no more than 1mA, which is much less than these I/O pins can handle, so everything is sweet. The 12-bit LED ring requires soldering of four header pins to slot into the breadboard.

You can take the audio from the headphone socket of your PC, phone or tablet. We use a standard 3.5mm TRRS (tip-ring-ring-sleeve) socket to tap the

SETTING THE RING BRIGHTNESS

`strip.setBrightness(num);`
...where 'num' is a number between 0 (off) and 255 (max brightness). Just be aware this LED ring is seriously bright when you crank it up, using up to 720mA of current with all RGB LEDs full-on. We've set a conservative value of '16' in the code to start you off.

If you haven't as yet, download the latest Arduino IDE from arduino.cc/downloads. Launch it and from the top menu, select 'Sketch > Include Library > Manage Libraries'. When the Library Manager appears, search for 'Adafruit NeoPixel', click on the entry and press the Install button. When you're done, grab our source code, unzip it, plug in your Arduino Nano board into your PC, load up the AudioLightShow.ino file, select the Nano board from the tools/board menu option, select the COM port (not COM1), then flash the source code to the board. Plug in an audio source and the LED ring should start dancing. ■



Creating exceptional code

Never assume your code users will always do what you expect. Darren Yates looks at how to make your Python apps 'fail gracefully' using exceptions.

Writing your own code can be a lot of fun – after all, you're developing a product or service you or others will use. The only problem is, you can't always predict what your end-users will do. For example, you may require a user to type in an ID number. What happens if a number entered is outside the index range? What if it's a negative number or a word? If they try to open up a file that doesn't exist, what happens next? If not catered for, these examples of user input in these particular applications would likely cause app failure. Exception handling is the technique of pre-empting input problems in a way that's often termed 'handled gracefully'. It's about maximising the user experience (UX) of your code and Python has built-in functions to make this easier to achieve.

SIMPLE STEPS

When you're coding for input from your users, the first step is to think about the type of input you're after. For example, say you have an app that returns the square-root of a decimal or 'floating-point' number (grab our source code from apcmag.com/magstuff and load up 'squareroot.py'):

IMPORT MATH

```
while(True):
    numltext = input("Enter
a number to get square-root:
")
    print(math.sqrt
(float(numltext)))
```

This simple code will indeed give you the square-root of a number, but it's also important to know the range of input for which this function is valid, or in other words, the 'input domain'. In mathematics, the square-root function is only valid for integers or floating-point numbers greater than or equal to zero (we won't consider complex numbers here), so that's the input domain for this function.

However, our code has problems. For starters, the input is a string – that in itself isn't wrong, but what happens if the user types in a word instead of a number? Or enters nothing but the Enter key? The input function will be fine, but the float() function inside the math.sqrt() function will crash because there is no way to convert the string 'two', for example, into a floating-point number.

ISDECIMAL?

Interestingly, while Python comes with a huge range of mathematical functions, one function it doesn't have

is to identify if a string of text is actually a floating-point number. Python does have an isnumeric() string function, but it only works with digits 0 to 9 and doesn't support a decimal-point. The solution is:

```
def isdecimal(number):
    try:
        float(number)
        return True
    except ValueError:
        return False
```

This common solution features the 'try/except' statement, which is a key Python feature allowing you to capture specific errors that may occur in the execution of your code and to handle them 'with grace' rather than the full dummy-spit of a program crash. Here's how it works – inside the 'try' clause, you put the code you want Python to at least attempt to execute. If the code works, open the champagne. If the code fails, the 'except' clause allows you to recover the situation.

```
squareroot.py - C:/Users/Darren/Python Code/Python_EP_23/squareroot.py (3.6.1)
File Edit Format Run Options Window Help
# how much commenting is enough???
import math

# try/except used here as it's more efficient than isdecimal() function
while (True):
    try:
        numltext = input("Enter a number to get square-root: ")
        math.sqrt(float(numltext)) # output not needed, just checking it works!
    except ValueError as errcode:
        print("**** ERROR: use digits 0 to 9 only.")
        print("**** CODE:",errcode) # errcode can't be added to string using '+'
    else:
        print(math.sqrt(float(numltext))) # yup, all good - print!

Comments that explain 'why' are always a good thing.
Ln 13 Col 68
```

```
Python 3.6.1 Shell
File Edit Shell Debug Options Window Help
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>> print(6/0)
Traceback (most recent call last):
  File "<pyshell#0>", line 1, in <module>
    print(6/0)
ZeroDivisionError: division by zero
>>>

Error messages are great when you're debugging code, not the end user.
Col 4
```


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5. Built-in Exceptions

In Python, all exceptions must be instances of a class that derives from `BaseException`. In a `try` statement with an `except` clause that mentions a particular class, that clause also handles any exception classes derived from that class (but not exception classes from which it is derived). Two exception classes that are not related via subclassing are never equivalent, even if they have the same name.

The built-in exceptions listed below can be generated by the interpreter or built-in functions. Except where mentioned, they have an "associated value" indicating the detailed cause of the error. This may be a string or a tuple of several items of information (e.g., an error code and a string explaining the code). The associated value is usually passed as arguments to the exception class's constructor.

User code can raise built-in exceptions. This can be used to test an exception handler or to report an error condition "just like" the situation in which the interpreter raises the same exception, but beware that there is nothing to prevent user code from raising an inappropriate error.

The built-in exception classes can be subclassed to define new exceptions; programmers are encouraged to derive new exceptions from the `Exception` class or one of its subclasses, and not from `BaseException`. More information on defining exceptions is available in the Python Tutorial under User-defined Exceptions.

When raising (or re-raising) an exception in an `except` or `finally` clause, `__context__` is automatically set to the last exception caught. If the new exception is not handled, the traceback that is eventually displayed will include the originating exception(s) and the final exception.

When raising a new exception (rather than using a bare `raise` to re-raise the exception currently being handled), the implicit exception context can be supplemented with an explicit cause by using `from` with `raise`:

```
raise new_exc from original_exc
```

The expression following `from` must be an exception or `None`. It will be set as `__cause__` on the raised exception. Setting `__cause__` also implicitly sets the `__suppress_context__` attribute to `True`, so that using `raise new_exc from None` effectively replaces the old exception with the new one for display purposes (e.g., converting `KeyError` to `AttributeError`, while leaving the old exception available in `__context__` for introspection when debugging).

The default traceback display code shows these chained exceptions in addition to the traceback for the exception itself. An explicitly chained exception in `__cause__` is always shown when present. An implicitly chained exception in `__context__` is shown only if `__cause__` is `None` and `__suppress_context__` is `false`.

In either case, the exception itself is always shown after any chained exceptions so that the final line of the traceback always shows the last exception that was raised.

5.1. Base classes

The following exceptions are used mostly as base classes for other exceptions:

exception `BaseException`

The base class for all built-in exceptions. It is not meant to be directly inherited by user-defined classes (for that, use `Exception`). If `str()` is called on an instance of this class, the

Check out the list of built-in exceptions over at the [Python.org](https://python.org) website.

"Writing your own code can be fun, but you can't predict what end users will do."

```

# Maths square-root function
import math

while (True):
    try:
        num1text = input("Enter a number to get square-root: ")
        math.sqrt(float(num1text))
    except ValueError as errcode:
        print("*** ERROR: use digits 0 to 9 only.")
        print("*** CODE:", errcode)
    else:
        print(math.sqrt(float(num1text)))
    
```

Capturing the initial error code enables you to print it to the screen.

What's more, the 'except' clause can handle specific errors separately.

In our `isdecimal()` function, we start with just the `float(number)` statement. Yep, it looks odd on its own like that, but we're not really interested in the result yet — we just want to know if the value of the 'number' parameter in the `isdecimal()` function header is a genuine floating-point number. If the `float()` function works, the value in 'number' is valid and we then return the Boolean value of 'True'. However, if `float(number)` fails — for instance, it has alphabet characters or an empty string — the `float()` function immediately fires off a 'ValueError' flag, which is caught by the `except` clause. Since we know at this point the value of 'number' isn't a floating-point number, we return 'False'.

SQUARE-ROOT FIX

We can now combine this with Python's `math.sqrt()` function, accounting not only for valid float-point numbers, but also add in checking for numbers greater than or equal to zero. You can see this in the source code 'squareroot_b.py'. Sure, there's more code — but it shouldn't blow up in the user's face.

CATCH ALL ERRORS

If you're not particularly worried about which error type is picked up, you can skip the error type in the `except` clause — instead of 'except ValueError:' as we've coded, you just use 'except:'. It's a bit like a catch-all 'else:' clause in an

how to » coding masterclass

if-else statement. This way, you catch every error that occurs, regardless of type. However, while it's easier to implement, it doesn't actually help you know why your code failed, nor does it help you inform the user why their input failed. For example, a user may type in an invalid filename, but is it because the filename begins with an illegal character or because the file doesn't exist? We're not saying don't use it, just be sure you know why you use it.

TRY-EXCEPT-ELSE

There are similarities between try-except and if-else, but the

try-except statement has extra options and one of those happens to be an 'else'. It's an optional extra, so you don't have to use it, but it may come in handy and is worth knowing how it works.

The 'try' and 'except' clauses you should now understand, the 'else' clause allows you to run extra code only if there are no exceptions arising from the 'try' codeblock. If an error is caught by the 'except' clause, the codeblock in the 'else' clause does not run.

How does it work in practice? Let's take our 'squareroot.py' source code and see if we can make it more efficient. For starters, we can lose the

isdecimal() function — it's a useful function to have, for sure, but in this example, we don't need it, because we can use the try-except-else statement to do everything for us in the one step. Take a look at 'squareroot_c.py' and you'll see that we've incorporated the try-except-else statement into our main code. We start by including the input statement and a math.sqrt() function call within the 'try' clause. If either of these statements fail with a ValueError, the except clause picks this up and prints the error message before looping back to the top of the while-loop. If, however, neither of these statements fail, we know that not only do we have a numeric input, but that the input is within the input domain for the math.sqrt() function. At this point, control passes to the else clause, which prints the square-root of the number entered by the user.

Essentially, the try-except-else statement allows you to incorporate error-checking into your code without having to add in extra if-else statements. It allows for a smaller and more elegant solution.

TRY-EXCEPT-FINALLY

The other option you can use is the 'finally' clause — here, code following the finally clause operates whether an exception has occurred or not. Personally, I've not found an application yet where I've needed it, since any code you place after the try-except statement will run anyway. And yes, you can combine them all to have a try-except-else-finally statement block if you so wish.

ERROR TYPES

One of the most common questions regarding the 'except' clause itself is what types of errors can it capture? Python has dozens of built-in exception types — you can read the full list on the Python website at docs.python.org/3/library/exceptions.html. Forget about remembering them all — just know the page exists and if you're coding and testing your apps, check here for the relevant types of errors that may crop up and make sure you account for them.

PRINTING THE RAW ERROR MESSAGE

Catching errors is clearly important, but sometimes, you also want to be able to see the actual error code as Python generated it, particularly when identifying errors or 'debugging' your code. You can do this simply by adding a variable to the except clause. Instead of:

```
except ValueError:
```

```
Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_23\squareroot.py =====
Enter a number to get square-root: 34
5.830951894845301
Enter a number to get square-root: 34.3
5.856620185738529
Enter a number to get square-root: -1
Traceback (most recent call last):
  File "C:\Users\Darren\Python Code\Python_EP_23\squareroot.py", line 6, in <mod
ule>
    print(math.sqrt(float(num1text)))
ValueError: math domain error
>>>
```

Our squareroot.py code doesn't handle negative numbers.

```
Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_23\squareroot_d.py =====
Enter a number to get square-root: 42
6.48074069840786
Enter a number to get square-root: -2
*** ERROR: use digits 0 to 9 only.
*** CODE: math domain error
Enter a number to get square-root: cat
*** ERROR: use digits 0 to 9 only.
*** CODE: could not convert string to float: 'cat'
Enter a number to get square-root: 23.1
4.806245936279167
Enter a number to get square-root: |
```

You can also print out the original error code, good for debugging.

Don't have Python? Download it from python.org/downloads

Download the latest version for Windows

Wondering which version to use? Here's how about OS differences:

Looking for a specific release?

Python releases by version number

Release version	Release date
Python 3.4.8	2016-02-09
Python 3.5.3	2016-02-09
Python 3.6.0	2017-12-19
Python 3.6.1	2017-10-03
Python 3.7.0	2017-09-19
Python 3.7.1	2017-09-19
Python 3.7.2	2017-09-19
Python 3.7.3	2017-09-19


```
squareroot_b.py - C:/Users/Darren/Python Code/Python_EP_23/squareroot_b.py (3.6.1)
File Edit Format Run Options Window Help
# Maths square-root function
import math

def isdecimal(number):
    try:
        float(number)
        return True
    except ValueError:
        return False

while (True):
    numtext = input("Enter a number to get square-root: ")
    if (isdecimal(numtext) and float(numtext) > 0):
        print(math.sqrt(float(numtext)))
    else:
        print("*** ERROR: use digits 0 to 9 only.")
```

Our isdecimal() function helps check that input matches requirements.

```
squareroot_c.py - C:/Users/Darren/Python Code/Python_EP_23/squareroot_c.py (3.6.1)
File Edit Format Run Options Window Help
# Maths square-root function
import math

while (True):
    try:
        numtext = input("Enter a number to get square-root: ")
        math.sqrt(float(numtext))
    except ValueError:
        print("*** ERROR: use digits 0 to 9 only.")
    else:
        print(math.sqrt(float(numtext)))
```

This version uses try-except for code control and error-checking.

Use:

```
except ValueError as
errcode:
    print(errcode)
```

What happens now is that when the except clause captures the particular error requested, it stores the original error code inside the variable 'errcode'. You then just print the variable with a standard print() statement. You can also choose any valid variable name you like to store the error code if 'errcode' doesn't do it for you.

As good as this option is, though, you probably don't really need to have your end-users seeing raw error code, so again, use it, but know when to use it.

BREAKING YOUR APPS

It's the one task few coders love doing, but it's arguably the most important. When you think you've finished coding your shiny new Python app, your goal should be to try and break it. Use it thoroughly and try to make it crash at every user input point – the idea is that you want to find every possible way of breaking your app, so that you can put measures in place to account for those flaws. This will likely require you delve down into every function, every codeblock and make sure they perform as expected and that each one can account for any errors in input applied.

This is typically called 'unit testing' and it's where you test individual

functions and source code files (few apps consist of just a single source code file) in a controlled environment, feeding your functions with specific 'edge case' inputs to see if those functions survive. For example, with our square-root function, an edge-case test might involve testing it with zero and negative numbers to see if the result is as expected.

The most difficult thing is balancing the amount of time you spend testing against the breadth and depth of testing you want to achieve. For most home-brew code, you get to decide that yourself. For code others will use, you want to be pretty confident the code isn't going to cause disaster and mayhem.

In professional programming, different companies will employ different software development strategies. One of the most popular you've probably heard of even if only in passing is 'Agile software development'. We won't go into it in detail here, but just briefly, Agile aims to develop apps iteratively in short stages, meaning that rather than develop a fully complete application in one step, you develop in sections – it makes large applications easier to code by breaking them down into bite-size chunks. It also keeps stakeholders in the loop and allows for any required changes to be made 'on the fly'.

However, it requires that testing also be performed in a similar manner – you can't just wait until the app is

finished, then go about testing it. Agile testing is essentially testing-as-you-go and a key part of the Agile process.

CODE COMMENTING

Still, it's not just end-users who use your code – it'll be very likely other coders. They may work with you in a team to develop a function or app, or they may follow you and be tasked with maintaining code you write. It might seem a strange thing to consider when we're talking about catching errors, but if your code is difficult to understand, you could well end up creating errors through misunderstandings later on (even if it's just you coming back to your code and trying to remember what you did!).

Adding comments to your code is as simple as starting with a hash '#' symbol and everything on that line from then on is ignored by Python when executing your code, but from a philosophical viewpoint, it's a far more complex issue. If you want to start a brawl amongst programmers, just lob in the 'code commenting is stupid' grenade, stand back and enjoy your handiwork, for as sure as night follows day, you'll start numerous fires.

There are several schools of thought to commenting. The first is that comments should explain the code in plain English, so that anyone following can get the gist of what's going on. However, another school says if your code needs comments to understand, your code's no good. Then there's the school that says comments should tell you not what you coded, but why you code it, the design decisions that led to a code choice.

The fact is commenting takes time, so if you do it, you want maximum value from it. I prefer the horses-for-courses policy – agree on a method with stakeholders and use it.

FACTS OF LIFE

I reckon there are two facts of life when it comes to coding – you'll make mistakes when you write your code and your users will make mistakes when they use your code.

In reality, the larger the app you develop, the more difficult it becomes to try and account for every possible error because you won't be able to mimic every possible usage environment. It all ends up being a matter of practicality. However, the ability to write code offering a high user experience or 'UX' will never go out of style. ■

games

The wingsuit makes a glorious return and is coupled with a parachute for finer control.

✓✓✓
apc
RECOMMENDS

PC, PS4, X0 | \$99.95 | FAR-CRY.UBISOFT.COM

Far Cry 5

Taking down a cult, one poorly-aimed rocket at a time.

On a bridge over a river in Montana, we are in a fierce battle with a roadblock set up by doomsday cultists. Civilians are running scared, their cars blazoned with the word 'SINNER'. The cult are extremely well-armed and organised, led by the enigmatic John Seed, a self-proclaimed prophet who's brainwashed his flock through fear and a potent drug. He's in hiding, having resisted arrest for taking people against their will, and his three lieutenants are now leading on his behalf.

It's a tense scene, but this being *Far Cry*, it's also not completely steeped in seriousness and tragedy. We're mopping two uteloads of goons when a third comes skittling onto the scene, along with a bear that had been chasing who knows what, and another terrified civilian. Our gun-

for-hire (returning redneck Hurk Drubman, last seen in *FC4*) neatly lines up the centre vehicle with his RPG and sets off a chain reaction that totals everything from cultists to civilians, and really upsets the bear which is now on fire. We decide to embrace the fiasco, necking a homemade homeopathic for extra strength, punch the bear to death for its skin, then jump off the bridge using a wingsuit and glide into the nearest town to sell the skin for \$100.

Far Cry 5 is, without a doubt, the most polished *Far Cry* ever. Hope County is enormous, a mountainous playground littered with vehicles to commandeer, planes and helicopters to fly, and the improved graphics engine gives everything weight and, believe it or not, a sense of realism. The freeform nature of it all perhaps offers too much freedom to get side-tracked from the story, but then

again it's the bits between the missions that have always been the most fun.

This time around, you no longer need to skin five animals to fashion a bigger wallet or better ammo pouch, nor go through torturous 3D platforming and climb towers to reveal new locations. Perk points, earned by completing missions or finding collectibles, are your new currency. Characters will allude to breadcrumbs that point you in the right direction to get more of these, but there's the right amount of hand-holding and discovery.

However, like a lot of Ubisoft titles, your screen will be overrun with icons and waypoints, a distracting swarm of what you haven't yet done, and after a while, it feels a lot like what came before. Or you can sink all your time into *Far Cry Arcade*, a map editor that also tosses in assets from

Assassin's Creed and *Watch Dogs* to play with. The community has already made some remarkable maps, and it's this that will give the game life beyond its 30 hour run time.

■ Paul Taylor



Verdict

Polished and the best it's been with that map editor, but it's time for an overhaul.





PC, XO | \$99.95 | WWW.SEAOFTHIEVES.COM

Sea of Thieves

An ocean of salty gaming tears.

We've been running up and down two flights of creaky stairs on this pirate galley for the last 10 minutes. There's a storm raging overhead and if somebody doesn't drain the hold, one small bucket at a time, then she'll sink. We're anchored at a small island after following vague directions scratched onto a treasure map.

Voice chat crackles: our mate is repeating something about "looking for three skulls facing east" and then "five paces southwest", while another scans the horizon for sails from the crow's nest. "Shit, I've just been struck by lightning," he squawks a few seconds later. But we no longer care, as we continue to heave into our dizzying, soul-destroying bucket-work. We don't know if we're having fun.

Sea of Thieves is an open-world shared-adventure game from Microsoft Studios. Players – from both PC and Xbox One – assume the role of pirates in an online, flooded world in search of treasure, fame and a new pair of pants. There are three main

factions players can run 'voyages' for – almost all of which are basic variations of the staple RPG fetch-quest, where you'll be asked to find something in the game world and bring it back. Easy. You're given a ship – a small sloop for one or two players, or a large galleon for three or more – a compass and a heading, and off you sail. Navigating around the sea is fun, the first few times you do it. Each ship features a map room or captain's quarters where you can plot a course. Navigating involves raising the anchor, checking wind direction and lowering/angling the sails to catch it as best you can. The smaller sloops only have the one sail, which is simple to manage for solo or duo teams, while the galleons have three.

When the cartoon-piracy gets dangerous, your ships come furnished with hefty cannons and players are equipped with a cutlass and hand-cannon for getting close and personal. Combat is a simplistic hack-and-slash affair, and any real fun is heavily reliant on the unpredictable nature that comes from random

encounters with other players.

A simple voyage can take anywhere from 10 mins to more than an hour. Ideally, rewards should reflect that effort, but sadly, they really don't. Pirating earns you gold, which you can use to buy cosmetic appearances for all your gear. You can't get better or faster at sailing, nor can you learn to shoot better or reload faster. There's no meaningful progression. The economy – and the will to continue playing – comes under scrutiny when it takes two or three gaming sessions just to earn some fancier pants. *Sea of Thieves* would be a better game if time-to-reward was tweaked. The chance for gold and cosmetic appearances to drop from in-game enemies would be a start, and give you a more compelling reason to leave the pub you spawn into. ■ Troy Coleman

Verdict

Open-world adventure piracy that's fun for a time, but needs something more to have any longevity.



apc
RECOMMENDS

Spellforce 3

A genre-blending hybrid that puts the RTS in RPG

PC | US\$50
SPELLFORCE.COM

Spellforce's flings RTS together with RPG, and contains the resulting fusion in a series of narrative arcs within a generic fantasy world. You build bases, raise an army, and take the fight to the bad guys as a mass of troops, rather than a small party of heroes. Although there is a small party of heroes, too, who have special powers and upgradable skill trees. Your companions are amiable enough and change at swift enough intervals to not get boring. They've always got something to say, and there's a rich vein of sarcasm to be mined in your responses. There are issues. The text contains a great many typos, but probably irks us journalists more than others. Areas highlighted as being of interest repeatedly fail to be interesting. We even had a loot drop that was impossible to pick up. This kind of thing is rare nowadays, and the developers continue to patch and improve the game post-release, and we didn't encounter anything game-breaking. The RTS sections make the game feel fresh. It's a balance that's been struck deliberately, and the mix works well. There's hours of play, and the fast pace means it's unlikely to get boring soon.

■ Ian Evenden





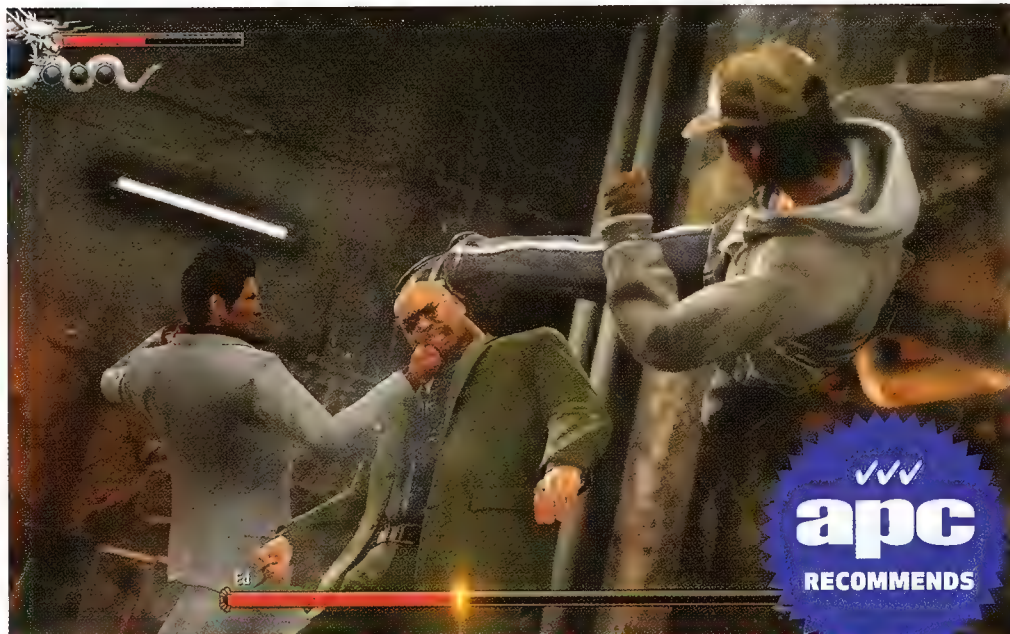
Burnout Paradise: Remastered

Riotous redux pulls a fast one.

PS4, XO | \$59.95
WWW.EA.COM

In real life, driving isn't that glamorous. Thankfully, Criterion's take on driving is a hell of a lot more fun than the real thing. The original *Burnout Paradise* first hit Xbox 360 over 10 years ago. Not that you'll feel like you're playing a decade-old title when you boot up this surprisingly spry remaster. With its breezy open world, addictive event structure, cute online challenges, and plethora of horribly moreish shortcut gates and billboards to smash, *Paradise* feels like every inch the modern racer. While the car-wrecking, blisteringly quick 60fps action is still fresh, visually you won't mistake Criterion's riotous road trip for a 2018 title. Even though Stellar Entertainment has done a fine job reworking road and building textures, as well as notably improving smoke and spark effects, this clearly remains a last-gen game with an extra shiny paint job. Not that you should be stopping to admire the roadside textures. It's been constructed so expertly, it's damn difficult to put the pad down once this open-ended racer sticks its spokes into you. Some design choices haven't aged well, though. For one thing, changing cars is a needlessly ponderous hassle. The remaster includes the *Big Surf Island* DLC and all toy and legendary vehicles unlocked from the off, too.

■ Dave Meikleham



PS4 | \$99.95 | YAKUZA.SEGA.COM



Yakuza 6

Bidding a fond farewell to one of gaming's greats.

Kiryu is certainly knocking on a bit. Early on, fresh out of a prison sentence imposed for his misadventures in *Yakuza 5*, he certainly seems to be feeling his age: he's unable to sprint for much more than 100 yards before stopping, bent double. A few upgrades later, he's back at his best, the only reminder of his advancing years being his wrinkles, the dark rings around his eyes, and the constant references to his age, the developers missing no opportunity to remind you this is Kazuma Kiryu's swan song.

Those unflattering features are powered by a new engine, meaning accessible buildings can now be entered without a loading pause. New fabric and skin shaders, combined with much improved lighting and animation, make a world we've come to know by heart feel more alive than ever. But the framerate peaks at 30fps and, on the base-model PS4, frequently plummets below that. If that alone doesn't have you pining for the good old days, then a world that



has markedly less to do certainly will. That's especially true in Onomichi, the Hiroshiman town where Kiryu spends far too much of the game. While bigger than it first appears, it's no Kamurocho in size, and certainly not in density.

Combat, too, has lost a little of its lustre. While ostensibly a more involved, more serious system, the loss of recent entries' multiple battle styles is keenly felt. Enemies are quicker to put up their guard now, and thanks to the new engine, attack in greater numbers. As such it's rare that you'll complete a combo without being twonked in the back of the head by an enemy you couldn't even see. In that context, the new Extreme

Heat mode — which sees Kiryu enter a Devil Trigger-style powered-up state — feels almost like an apology.

If all that sounds disappointing, rest assured that, to series fans, none of it matters. While it takes the customary age to get into its stride, *Yakuza 6*'s narrative builds to one of the finest climaxes in the series. When the dust settles, you're given something that no previous *Yakuza* game has ever offered: closure.

Verdict

The *Yakuza* series will continue, but with Kiryu out of the picture, it will never be the same.





PC, PS4 | \$50 | WWW.FINALFANTASYXII.COM

Final Fantasy XII: The Zodiac Age

The smartest game in the series has finally made it to PC.

Dalmasca has been invaded by the forces of Archadia and it's up to a couple of street urchins, a resistance leader, a knight, a sky pirate and a rabbit lady to save the realm. There's an airship and Chocobos – so far, so *Final Fantasy* – but look past the iconography and you'll find the boldest, most inventive game of the series, powered by a weighty squad-based RPG system and remastered to run at high resolutions on PC.

After a brief scene-setting prologue, you start the game in control of Vaan, a charmless teen from the streets of Dalmasca. He's hitting rats in a sewer alone and seems determined to give you the worst possible introduction to *FFXII*'s world and systems. As you guide him around town and into the surrounding deserts to hunt monsters, you pick up companions like his streetwise pal, Penelo, and the fantastic sky pirate Balthier. Once you have a full squad, the combat system slowly reveals itself,

and the fun can truly begin. Fighting happens seamlessly as you wander around open areas – no separate battle scenes here. When an enemy attacks, everyone draws their weapons, then you're free to give commands to any party member, which they execute as soon as their cooldown timer has expired.

FFXII isn't really a game about micromanaging individual actions, but rather a design challenge in which you tailor the party's AI to turn it into a self-sustaining death ball that rinses dungeons with deadly efficiency. You edit each individual's behaviour between battles with the Gambit system. This looks like a list of commands which you can customise and then drag around to create an order of priority. You can buy new commands from shops, too. The License Board system adds to the appeal, allowing you to cast any character in any battlefield role. Together, this makes developing a party a satisfying exercise. Even though Balthier turns

up with a gun and Vaan has a knife, you're free to throw out the game's idea for each fighter entirely.

XII's greatest problem is that it takes so long to get good. The remaster counters this with a fast-forward mode that lets you double or quadruple the speed of the action. This brute force gets you through the duller intro dungeons quickly, and clips hours of grinding. If you approach *XII* as a vehicle for party experimentation, it's easy to fast-forward to the quality extracurricular stuff, like the hunting lodge that lets you fight through a series of intense monster battles.

If you like theorycrafting, clever levelling systems and lavish worlds, this could easily be your new favourite *Final Fantasy*.

■ Tom Senior

Verdict

A decent port of a great *FF* entry with one of the cleverest combat systems in an RPG to date.



Into the Breach

A minimalistic mech tactics game

PC | US\$15
WWW.SUBSETGAMES.COM

If you've played *FTL*, you'll know the panic of a no-win situation. *Into the Breach* will bring that feeling back, and it's wonderful. Developed by the same team, it's built on the same roguelike progression, interplaying abilities and knuckle-gnawing tension.

Into the Breach is a turn-based tactics game in which your squad of three mechs faces a swarm of ground-dwelling bugs, the Vek. Each level is played out across just five turns on an 8x8 grid, and your goal is survive, build up your mechs, and finish the Vek off in a final battle. But its party trick is that you see what the Vek will do on their turn. The tactics are tight and controlled because you know the exact results of your every move. You know what the Vek will be attacking, for what damage and in what order. That evens the odds, even while you're almost always outnumbered. You also have amazing weapons on your side. Thinning the Vek's numbers is always a good idea, but many weapons can also move them and relocate their attacks. If you're clever, you can make them hit each other or push them into hazards. You always have many options, but you're rarely sure you're choosing the best. *Into the Breach* fuels the most consistently rewarding tactics we've played in years.

■ Alex Wiltshire



downtime » chip

» CARMEL SEALEY REPORTS ON THE LIGHTER SIDE OF TECH NEWS

Cortana inadvertently opens the door to hackers

"I'm sorry, Chief."

Microsoft's voice assistant, Cortana, reportedly has a security vulnerability that allows hackers to completely bypass the Windows 10 login screen. A team of Israeli researchers discovered that Cortana is always on (to be ready to respond to voice commands), even when the computer is locked, meaning she — and by extension, the computer — can be interacted with. Theoretically, this gives a hacker the opportunity to physically connect a device (a USB, for instance) with a network adaptor into the PC, then give Cortana the order to launch the browser and head to a certain unencrypted website. Cortana will apparently comply. "We can attach the computer to a network we control, and we use voice to force the locked machine into interacting in an insecure manner with our network," one of the researchers explained. "We still have this bad habit of introducing new interfaces into machines without fully analysing the security implications of it," a colleague added.



Flippy the burger bot shown the door

FIRED AFTER ONLY ONE DAY ON THE JOB.

For those worried about robots and AI coming to steal our jobs, here's a bit of good news. The burger-making robot Flippy didn't quite click on his first day of work at CaliBurger. Before you punch the air with glee, we should probably mention that this isn't because he did a bad job. No, this was because he did his job of flipping patties so well that his human coworkers couldn't keep up. Flippy received his orders digitally, whereas the squishy humans around him relied on verbal communication to keep in touch with each other and sync their duties. This meant that Flippy was essentially isolated in his work — flipping his burgers and buns according to programming and orders — and everyone had to keep up with him, rather than work in sync with each other. While he might be off duty now, Flippy is expected to return to work after some adjustments are made... although, whether that's to his speed or to the involvement of humans around him, we don't know.



HAL 9000 and Alexa team up to control your home

MRG PRODUCES SMART HOME REPLICA.

2001: A Space Odyssey is a classic sci-fi movie featuring the iconic sentient artificial intelligence HAL 9000, the ship's computer. While, in the film [Spoiler alert! — Ed], the malfunctioning HAL turns to murder in order to save the ship and its mission, we're hoping this replica doesn't get any similar ideas. Master Replicas Group isn't just making something that looks pretty for diehard fans, after all. This HAL is supposedly being created to have full voice recognition software — allowing you to ask the time, weather, perform basic smart home tasks and so on — with Amazon's Alexa the brains behind the ominous red dot. While MRG hasn't yet released any specs or prices, we're expecting it to cost a small fortune.

Rejoice! Crumb-resistant MacBook keyboard patent filed

TAKE YOUR FUTURE LAPTOP TO THE COUCH.

Good news, slobs! You will soon be able to both work on your MacBook and scoff your face with crisps, popcorn, biscuits and all manner of crumbly things with confidence at the same time. A patent application was made public in early March this year, stating that Apple might soon be featuring a new-and-improved keyboard in their MacBook range that makes it nearly impossible to get dust and grime stuck under the keys. While the application doesn't expressly show or explain how Apple plans to achieve this feat, it did suggest that a potential solution could include a membrane underneath each key, sealing off the interior. In the meantime, humans, stop being grubs and take your food away from your laptops. ■

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